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POWER

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Engineers and Engineers

THE word "engineer" suggests different types of individuals and different kinds of functions to different minds.

In the old days Henry R. Worthington paid E. D. Leavitt a retaining fee and carried his name upon his letterhead.

One day an excited customer called up on the telephone and wanted to talk with Mr. Leavitt.

It was explained to him that Mr. Leavitt was connected with the company only in a consulting capacity and was seldom at the office.

It turned out that the customer's pump had stopped and he wanted Mr. Leavitt to come over and fix it.

In the opposite sense, word came from the operating engineer of a manufacturing concern that he was in trouble and wanted somebody who could fix a pump.

The chief engineer of the pump company happened to be in the vicinity and was directed by telegraph to see what was the matter.

When he appeared, attired as befitted the important meeting from which he had just come, the abashed engineer said, "Gee! I didn't send for a man like you. I want a mechanic."

After some conversation indicating that the visitor knew something about pumps, the engineer led him to the engine room and pointing to a dismantled pump acknowledged shamefacedly, "I took those blasted water valves out and I can't get them back to save me."

In a pair of borrowed overalls the big man deftly replaced the obdurate valves and showed the engineer the knack of it so thoroughly that he never had any more of that kind of trouble.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Taking the Gamble Out of Stream Flow

EVER since man began to use water power he has proceeded on the theory that the amount of water that might be available at any one time depended upon chance. If there happened to be a wet season plenty of water could be expected. A dry season presaged a water shortage. This doctrine of chance has no place in present-day power-system operation. Modern hydro-electric plant design and operation require advance information on the amount of water that will be available. The growing importance of this problem has caused increased attention to be centered on predicting rainfall and stream flow.

Storage reservoirs on rivers to equalize the flow have not proved to be as successful as was at first expected. In some instances prolonged dry periods have resulted in a water shortage, something that the reservoir was expected to prevent. In other cases, unexpected wet periods have been approached with the reservoir full, when provision should have been made for storing at least part of the excess water. If these conditions are to be avoided, methods must be provided to predict the amount of run-off one or two years or even longer ahead. There are many problems in hydro-electric plant operation that can be intelligently handled only by advance data on stream flow.

At first thought the problem of predicting rainfall and stream flow years in advance of the flow period might appear a hopeless task. Until comparatively recently this problem has been considered as such. However, research based on the frequency of the sunspot cycle, the thickness of the ring growths on trees, the rise and fall of lake levels and on other phenomena gives promise of a reliable method of predicting stream flow. The problem is a complicated one and involves many variables, but, as pointed out in the article on predicting stream flow in this number, it is possible to determine run-off cycles for a long period in the past. By various means it is apparently possible to establish relations that show the volume of stream flow in any locality to be subjected to natural laws and is not a matter of chance.

Predicting stream flow has not as yet been developed as an exact science. A good start has been made, however, and in the near future it may be possible to predict future water supply for any hydro-plant. Such predictions in certain localities have been made, with a surprisingly high degree of accuracy.

Light Celebrates Its Golden Jubilee

NOT many realize that fifty years measure the whole period of modern lighting—electric lighting. But it was not until 1879 that this great facility, which has become a necessity of all our lives, had its beginning. It was in that year that Thomas A. Edison, that grand old man of American science, completed the experiments that gave the world the incandescent light of today.

From the crude and simple lamps of that time, sparingly used at considerable expense, has grown the great lighting industry. Without this development all our vaunted industrial progress could not have come about. It is even doubtful whether all the world's present population could have maintained life on the earth, and it is certain that they could in no case have found comfort and plenty.

Based, as it is, on power, electric lighting has been responsible for a great growth in power generation facilities. Not only does the electricity consumed by lighting demand ever-larger power plants, but this lighting has made possible a great growth in manufacturing that also uses increasing power supplies.

The whole power field is intimately connected with electric lighting and, in part, dependent upon it. Therefore, what could be more fitting than that power engineers should take their due share in celebrating light's golden jubilee—Edison's great achievement of fifty years ago? From June first, culminating on October twenty-first, when the actual anniversary of the invention occurs, the whole country will honor the event with meetings, pageants and illuminations. Let us all do our best to make these occasions suitable and memorable observations of what was one of the greatest days in recent history.

Installment Buying

IT IS almost trite to point out that reluctance or inability to make the necessary cash expenditure for much needed improvements is responsible for many industrial power plants struggling along inefficiently under the handicap of obsolete equipment. In many cases the managements are fully aware of the savings possible but they just cannot see their way clear to divert the necessary money from manufacturing activities and they hesitate at incumbering their financial setup with bond issues.

Installment buying has become an accepted practice in the consumer field. In spite of the dire predictions of certain economists it has stimulated prosperity without incurring unsound conditions. It has penetrated the industrial field only in spots, but where applied the reports have been generally favorable.

As pointed out by Mr. Lewis in this number, the principle of installment buying offers many possibilities both to the users and to the makers of power equipment. Here the problem is not as simple as in the merchandizing field and factors are continually being uncovered whose solutions will evolve standards applying to the industrial field. However, Mr. Lewis has pointed the way, discussed the problem broadly, and indicated a few of many cases where the principle has been applied. The subject warrants consideration by those whose plants are in need of modernization and by those equipment manufacturers whose products fit well into the picture.

Power Developments in the South

THAT the South no longer thinks from an agricultural viewpoint alone is evidenced by its rapid industrial development. Hardly a village in the Carolinas, Georgia and Tennessee but has its paper, textile or furniture factory.

While the motive that prompted the industrial invasion of the South may have been, as often claimed, the availability of raw materials and labor, these factors would have been futile to effect the great change in the absence of cheap power.

The emergence of the South from the prostration that existed for two generations after the Civil War can be attributed largely to the existence of power resources in the form of water and coal beds. Probably more than any other section the South owes much to those large public utilities, such as the Duke Power Company, that boldly developed water-power sites and strung a network of transmission lines to meet the future demands of a then non-existent industry. But factories of local ownership gradually came into being, and the manifold advantages of this region became so apparent that there occurred what may be termed the "New England invasion of the South," resulting in the South replacing New England as the textile center of the country.

Originally, most of the industrial undertakings found that power could be purchased at a rate under the cost with a factory power plant. Consequently, only in those mills where there was a demand for process steam was power generated on the premises. But at present there is a drift toward the installation of factory power plants, and many of the new mills have their own generating units. This trend is due both to the fact that many textile mills are now doing finishing, requiring considerable process steam, and to the improvement in the efficiency of power equipment.

In the early mills steam pressures of under two hundred pounds were universal. With fire-tube boilers and the type of engines in use, power could not be developed cheaply, as processes required steam at twenty-five pounds pressure, the boiler pressure was too low to permit using the engine exhaust. But the development of the high-pressure water-tube boiler of a capacity suitable for mill work and the perfection of the extraction turbine have upset the previous power set-up.

New mills are installing high-pressure boilers with water walls to permit overratings and are extracting steam from the turbines at pressures ranging from one hundred pounds downward. Mills having low-pressure boilers and reciprocating engines are adding high-pressure boilers to supply steam to a turbine that exhausts either into process mains or into the low-pressure boiler mains.

While scores of power plants have been modernized already, there is every indication that the movement will experience a greater impetus, now that the mill wage scale is being adjusted to higher levels, which makes economy in production all the more necessary. As a body the Southern consulting engineers declare that power-plant construction will be greater this year than ever before.

The End Justifies the Means

SAFETY has become a slogan in American industry, but how to make the employees think and act safely is still a much discussed problem. Many suggestions have been made to accomplish this end, but few of them have proved successful. It has been found that accidents happen after all kinds of safety devices have been provided and safety engineers and committees have been made responsible for conditions in the plant. Experience has shown that unless the individual will look out for his safety, he will get injured, no matter how many guards are provided to protect him. The problem, after reasonable safeguards have been provided, comes down to one of making the worker think and act safely.

At the Philadelphia plant of the Midvale Steel Company, employing about two thousand men, a record of one hundred and three working days without a single off-time accident has been made. After trying various methods of applying safety principles, a system of intensive education and strict discipline has been applied. one of the outstanding features of the discipline is to penalize the one who gets injured and his associates for not acting safely. Every man working in a gang is held equally responsible for the accident. If one gets injured, all are laid off for a period ranging from the rest of the day to the remainder of the week from the time the accident happened, depending on the seriousness of the case. In this plant the executives are giving this movement their whole-hearted support.

The results speak for themselves. When employees know they will be disciplined more quickly for an infraction of safety rules than any other, the safety idea is getting across. Some of these cases of discipline may seem to border on unjust treatment, but the one object of safety is to prevent accidents. If treatment that may be a little difficult to justify is going to save someone from being killed or prevent serious injury, the end justifies the means. The methods employed by the Midvale Steel Company merit the careful consideration of everyone interested in the safety movement including those operating power plants.

"It's Simply a Matter o

Pullman Economists Solve Insulation Problem

By P. W. Swain
Associate Editor of Power

"YES, I grant that the more you put on the more it costs, but I'll be darned if I can get this thing they call 'economic thickness' through my head. As far as I can see the economic thickness is the heaviest the manufacturer can unload on the unsuspecting customer."

"Economic thickness isn't such a mystery as some folks imagine. It's simply a matter of dollars and cents."

"I'll grant that without any argument Thicker heat insulation means more dollars and cents for the manufacturer and for the white-haired boy who sells me the stuff."

"Well, I'll let you into a little secret since you raise that point. I happen to be a salesman myself and—believe it or not—my line is heat insulation. My name is Jones."

"Mine is Mackenzie; I'm plant engineer for Mistproof Weaves, Incorporated. I may as well admit that we're adding some new boilers, process lines and water heaters and that I'd really like to do a scientific job of heat insulation on this new equipment. That's how I happened to light on this subject of economic thickness."

"Have a cigar, Mr. Mackenzie."

"Thanks, Mr. Jones, I suppose this ought to increase the economic thickness a half inch at least—and perhaps help me see the superior qualities of your particular brand of heat insulation, which is . . . ?"

"Now, Mr. Mackenzie, you're still thinking of that last insurance salesman who tackled you on your busy day and painted a lurid picture of your widow and orphaned children weeping over your coffin. Just to fool you I won't mention the name of my concern. I *will* name the product, which happens to be a non-patented staple article made by several manufacturers—'85 per cent magnesia.'"

(Photo Ewing Galloway)

"You're still thinking of that last insurance salesman who tackled you on a busy day . . ."

r of Dollars and Cents"

Here the 2½-in. block pays best

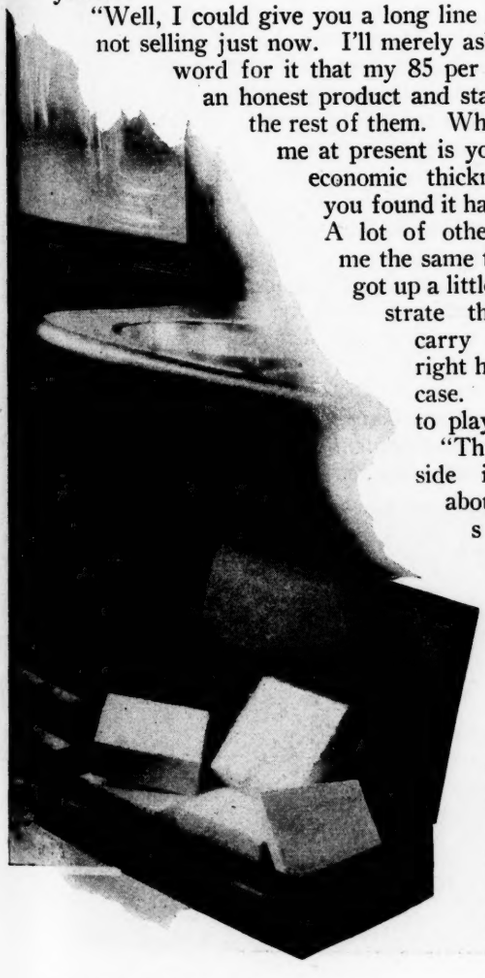
Total Cost.....	8c.	12c.	16c.	20c.	24c.
Total saving.....	46.9c.	48.9c.	49.9c.	50.6c.	51.1c.
Total return.....	585%	408%	312%	253%	213%
Cost of increase...	.....	4c.	4c.	4c.	4c.
Saving on increase.	.....	2.0c.	1.0c.	0.7c.	0.5c.
Return on increase.	.....	50%	25%	17.5%	12.5%

"Yes I know that material, and have used it for years. It's 85 per cent of carbonate of magnesia, mixed with 15 per cent of asbestos fiber."

"Right! Magnesia for heat insulation and asbestos fiber as a bond to give it strength. The things to look for in this material are light weight, which means high insulating value; long asbestos fiber, which means strength; good-quality canvas, which means life, when you come to think of it; and, of course, good workmanship, careful packing and all that."

"How does your product stand in these respects, Mr. Jones?"

"Well, I could give you a long line about it, but I'm not selling just now. I'll merely ask you to take my word for it that my 85 per cent magnesia is an honest product and stacks up well with the rest of them. What really interests me at present is your remark about economic thickness. You said you found it hard to understand. A lot of other engineers told me the same thing, so I finally got up a little game to demonstrate the principle. I carry the whole kit right here in my sample case. Would you like to play?"



"There's a sign outside in the corridor about avoiding card sharps — you know," laughed Mackenzie. "But if it doesn't cost anything to see you—go ahead."

"Well, you do need a little money, but I furnish the cash myself to avoid any anxiety on that score." Jones rummaged in his sample case and pulled out half a dozen blocks of 85 per cent magnesia and a small pile of pennies. He also produced a card on which was printed the following table:

Thickness Inches	Price	Yearly Saving for Slab 6 in. Square	Efficiency Per Cent
1	8c.	46.9c.	87.6
1½	12c.	48.9c.	91.2
2	16c.	49.9c.	93.1
2½	20c.	50.6c.	94.4
3	24c.	51.1c.	95.3

"The savings," said Jones, "are based on 160-lb. steam pressure, at which figure the loss from the bare surface would amount to about 856 lb. of coal per square foot per year of continuous operation. The average efficiency of 85 per cent magnesia under given conditions varies only slightly from one make to another. If you want to, later, you can check my figures from data given out by disinterested testing laboratories. The savings are those obtained by putting the covering on a flat surface and are based on a delivered coal cost at $5 per ton for the purposes of this game. Are you ready to start, Mr. Mackenzie?"

"Just as you say, but I warn you that I haven't a ghost of an idea what it's all about or what I'm supposed to do."

"Don't let that worry you. Here are seven stacks of pennies for you, 4 cents in each stack. Here's my pile of magnesia blocks."

"Say, are you trying to sell me that stuff?"

"Yes, but you're going to buy it with the money I gave you, so what's your kick?

"All right. Now Mr. Mackenzie, I have here a bright new piece of magnesia, one inch thick and six inches square, which I will sell you for the insignificant sum of eight cents."

"Is it worth eight cents to me?"

"*Is* it? Take another look at that table. When applied to a patch of hot surface in the plant of Mistproof Weaves, Incorporated, it will save 46.9 cents per year in coal—and remember that the table is based on certified tests, not on some salesman's imagination."

"Fair enough, Mr. Jones; here's 8 cents; hand me the block."

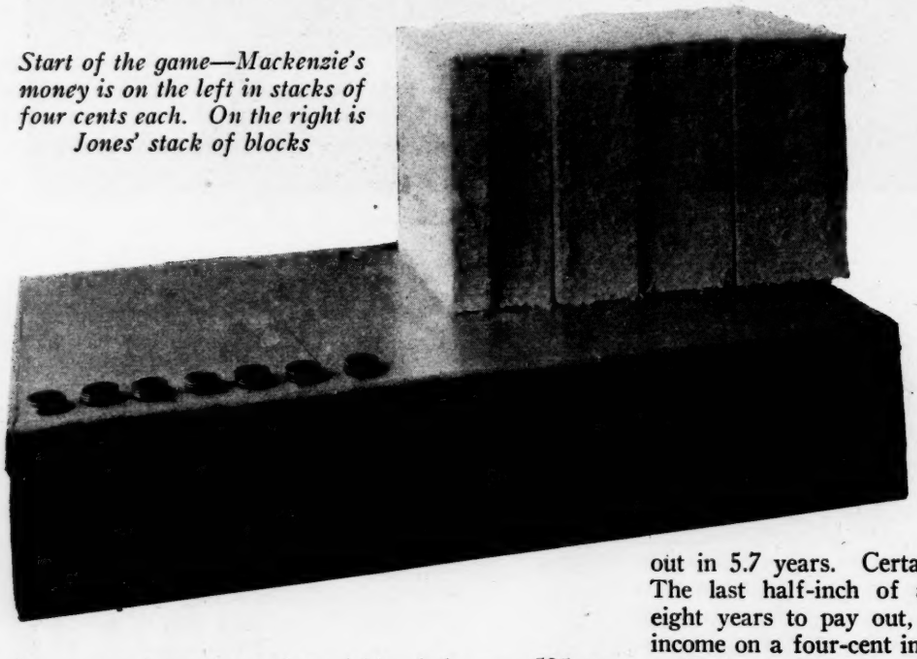
"Now, Mr. Mackenzie, you made a very good bargain a moment ago, but I have another proposition to make. Why don't you change your order and buy this inch-

and-a-half thick piece instead; it will save more coal."

"Fifty per cent more?"

"I'm sorry, Mr. Mackenzie, but that is impossible since the first piece saves 87.6 per cent of all the coal that would be wasted from a bare surface. The 1½-in. block will save you 91.2 per cent."

"This is a skin game and I'll stop right here. You



Start of the game—Mackenzie's money is on the left in stacks of four cents each. On the right is Jones' stack of blocks

give me an investment that yields—let's see—585 per cent return, 46.9 cents a year on a capital of eight cents. Then after the bargain has been made you want me to swap for an investment that pays a measly 408 per cent, 48.9 cents a year on twelve cents. Why don't you give me 585 per cent on my twelve cents?"

"You hit the root of the power-plant investment problem, but the ax turned in your hand. In every plant there are opportunities to invest sums at enormous returns. But all these opportunities are limited. If they weren't we'd all be millionaires. A five-dollar patch on a leaky oil tank might save you hundreds of dollars yearly. When the patch is on, that avenue for investment is closed, and you naturally turn to the next best return for any additional money you have to invest. It's the same here. The one-inch thickness is a golden opportunity to invest eight cents at a return of 585 per cent, but I won't take any more of your capital at that rate. Since no more of this 585 per cent investment is available, do you mean to tell me that you are not willing to accept an additional return of two cents yearly on an additional investment of four cents? Did the recent bull market so affect your mind that 50 per cent doesn't interest you when you can't do better?"

"Well, it does sound plausible. Here's four cents more and your old one-inch block. Hand me the inch-and-a-half block."

"You have acted as any good business man would under the specified conditions. And now, Mr. Mackenzie, how about another half-inch? The two-inch block will cost you four cents more and save you another cent over the inch-and-a-half block. The additional investment will pay out in four years."

"Well, Mr. Jones, my resistance is beginning to increase."

"You're right, it ought to, you're getting near that so-called 'economic thickness.' But don't you find that you are generally justified in your plant in making an investment that pays itself out in four years. Mind, we're not talking now about this whole two-inch block—it'll pay for itself in four months—but just about this last half inch. It's up to you, is it a go?"

"Well—I guess so; here's the four cents and the old block, but it's about time to call this game off—the pickings are getting thin."

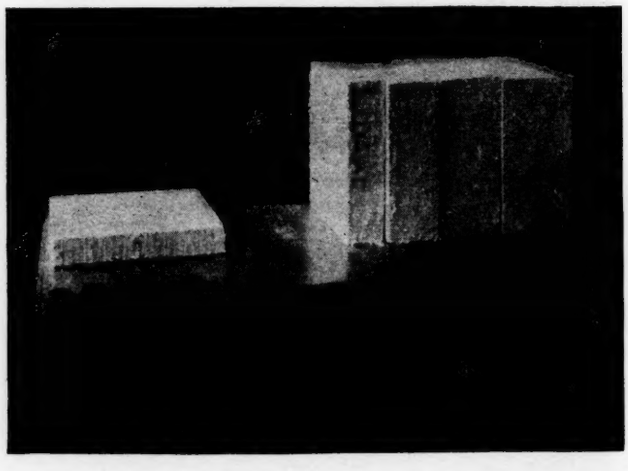
"Here's your two-inch block, Mackenzie, and the admission that you are right. You are near the economic thickness. Every extra red flannel shirt you put on does a little less good than the one before, but costs just as much. It stands to reason that there's an economic limit to the thickness of pipe covering just as there is to winter clothing, a point beyond which the game isn't worth the candle. I wouldn't force the issue, but another half-inch might be worth considering. It would pay out in 5.7 years. Certainly that is the economic limit. The last half-inch of a three-inch block would take eight years to pay out, since it gives only a half-cent income on a four-cent investment."

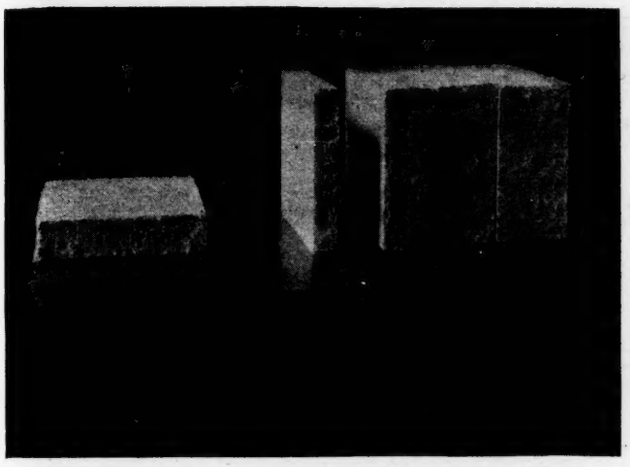
"Let's see how we stand," mused Mackenzie, lighting another cigar, "I'm out 20 cents capital and in a saving of 50.6 cents per year on coal. Looks pretty good, but it still seems phoney, because I started out to make 585 per cent and now I am only making 253 per cent. Nevertheless, all the reasoning seems O.K. and I guess we'll have to call it quits."

"Well," said Jones, settling back in his seat and adroitly swiping Mackenzie's block and pennies, "we did overlook a few fine points, but we had to keep the game simple.

"There is the matter of application costs, for example, but that has very little effect on the economic thickness, because we were working with differences and they are hardly affected.

First move—Mackenzie hands over eight cents for the 1-in. block. The investment will yield him a yearly return of 585 per cent





Second move—Four cents additional invested in a 1½-in. block pays 50 per cent. Mackenzie's total yield now falls to 408 per cent, yet he is better off

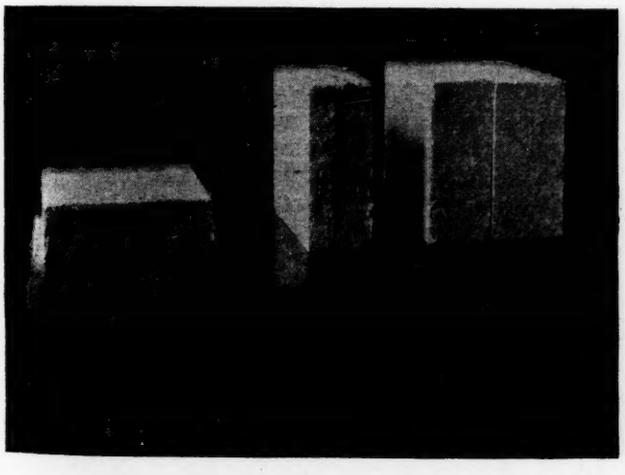
"Again—but don't tell anybody—I overcharged you for those blocks. You paid a bit over the list price whereas you ought to get about 50 per cent discount. A standard list price of thirty cents per square foot one inch thick has been used for years by all magnesia manufacturers. This list price increases in exact proportion to the thickness. At this rate the list price of a six-inch square one inch thick should be seven and one-half cents. With current discounts you could buy it for four cents and pay only two cents for each additional half-inch. If you should play the game again on this basis, it would double your percentage return all along the line and give an economic thickness of three inches or even more.

"Another rather big matter was overlooked, but that works the other way. I refer to pipe curvature; our game was played with flat blocks. Don't get the idea, however, that you must put three- or three-and-one-half-inch covering on a one-inch pipe, just because it happens to figure out right for a flat surface."

"How's that?" Mackenzie demanded.

"It's like this," replied Jones. "A one-inch standard pipe is four inches around—believe it or not. Now every time you add one inch to the radius of a pipe, you add 2 x 3.14 or about 6¼ in. to the circumference. So the outer circumference of a one-inch covering on this pipe will be 4 + 6¼ = 10¼ in., and of a two-inch covering will be 10¼ + 6¼ = 16½ in. A piece of two-inch-thick covering 'wrapped' around this pipe will have a 'width' of four inches on the inside and 16½ in. on the outside, or an average of 10¼ in. to cover a four-inch circumference. Now since we are not in business for charity, it is obvious that you will have to pay for a block 10¼ in. wide and two inches thick. The thicker the covering the 'wider' the block.

Third move—Another four cents pays for the last half inch of a two-inch block and the yield on the additional investment is 25 per cent



"It all comes down to this in the case of pipe covering. Each additional half-inch of thickness costs more than the previous half-inch. At the same time there is less gain from an additional half-inch than there would be in the case of flat blocks, because the area for the passage of heat is getting larger and larger as you work out from the center. So the added cost is more and the saving is less than with flat surfaces, and you naturally reach the economic thickness earlier. This effect is most pronounced with small pipes. Hence, smaller pipes have smaller economic thicknesses.—Q.E.D."

"Look here," Mackenzie shot back after a long pull at his cigar, "this was all beautifully simple and now you ball it all up again. I have hot surfaces all the way from one-inch pipe to flat plate. I would have to play this game of yours from now until next Thanksgiving to get the right thickness for all these pipe sizes. How about it Mr. Jones?"

Fourth move—About time to quit, but Mackenzie takes the 2½-in. block getting 17.5 per cent on the last four cents invested. He has reached the economic thickness

"You're right, but don't worry. The game served its purpose when it gave you the idea, and the idea is absolutely sound science and business. The practical choosing of economic thickness is easy enough. Just thumb the catalog of any established manufacturer of heat insulations and you will find a complete list of economic thicknesses for various pipe sizes, steam pressures and costs of fuel. If your conditions are unusual, you can easily get some salesman—me for example—to figure you out a special table to fit your own conditions and the actual sales prices exactly.

"Good-bye Mr. Mackenzie. Here's my station. Drop me a line if you want me to bid on your job, but whatever you do, don't leave those pipes bare while you fiddle around deciding which make of covering to buy. Remember that those bare surfaces are wasting the entire cost of the job every three months, while you are making up your mind. An extra five points off the list price will be a loss if you waste ten days to get it. Good-bye."

INSTALLMENT BUYING

Opens Up

New Power Possibilities

By H. Bertram Lewis
Vice-President, Commercial Credit Company, Baltimore

Many industrial power plants are sorely in need of modernization. The managements are aware of the savings possible, yet cannot see their way to make the necessary expenditure. Installment buying offers an easy means of financing such equipment with payments being offset by the savings that have been effected.

THE City of State Center, Iowa, decides to modernize its power plant at a cost for new Diesel equipment of $20,982 and with an estimated annual saving of $4,000 in sight. Usual sources of municipal credit for communities of equivalent size are not propitious. The cost is excessive and the red tape onerous. "No need for cumbersome financing," says the Diesel manufacturer. "Our finance company will take your paper on a four-year basis. You pay down a quarter of the purchase price and the balance in forty-eight monthly installments. The carrying charge will be moderate; the term of the note limited to a period within which the anticipated economies will almost have paid for the plant. You will not be paying interest on your money for years and years after the savings of the new equipment might comfortably have liquidated your indebtedness. Your payments will virtually keep pace with the returns from your investment, and when these have wiped out the installation cost, you will be clear of all encumbrance on account of this transaction."

And on those terms the sale was made with profit to all concerned. The municipality got its needed new equipment without delay on a four-year credit basis. The Diesel engine manufacturer made a substantial sale, received the cash price in full and kept his working capital in circulation. The finance company received high-grade paper, with low acquisition cost in proportion to the average amount outstanding during the liquidation period.

The City of Sullivan, Illinois, paid down to the same manufacturer $9,845.84 on a $46,999 Diesel installation, the balance due in fifty-six monthly installments. Its anticipated saving is $10,330 per annum. And scores of other towns, cities and other power producers in all sections of the country have, within the last two years, found in the finance companies the answer to many an equivalent credit problem.

A manufacturer faced with the choice of wholesale modernization or eventual extinction, contemplates a $500,000 bond issue. Tedious negotiations develop an underwriting offer of 95 for the bonds, a 6 per cent interest rate for a 25-year term and, as a consideration for negotiating the loan, the transfer to the underwriters of 33⅓ per cent of his common stock. On the other hand, the installment terms of a finance company competent to handle business on that scale would have wound up the transaction within a three-, four- or five-year period, at less cost to the buyer and with far less time required for the negotiations. The plant would have been paid for within the active life of the equipment and presumably from the increased earnings or savings accruing from its use, and the obligation would have been wiped off the books completely before a new modernization program became essential.

The installment selling principle, hitherto limited in

its use to the consumer field, has definitely made its entry into the field of production. And the advance indications are that its greatest future development may be looked for in the financing of plant equipment. For it is the thriftiest and most convenient purchase plan available today to a majority of plant equipment buyers.

It is necessary, at this early stage in the process of adapting it to industrial requirements, to realize that experience will teach many things about its possibilities, and perhaps about its limitations, which are not known now. But one thing has been conclusively demonstrated by the developments of the last two years, namely, that it is a thoroughly practicable form of credit for industrial financing and that a high percentage of all producers can utilize it advantageously in connection with sorely needed modernization programs.

Application will come about by one of two methods; perhaps by a combination of them. Either manufacturers of plant equipment will adopt the installment selling principle universally for their individual products, or the finance companies will on their own account undertake the financing of complete installations, buying the equipment outright from manufacturers and reselling it, on suitable title retaining instruments, to the purchaser. Under the latter plan the equipment will be selected by disinterested engineers and the owner of the plant will install that which is specified. Under the former the manufacturer with a finance company connection of his own will offer suitable terms direct to his customers and will command his own market so far as the basis of sale is concerned.

Two Methods Compared

The two concrete illustrations with which this discussion opened were of the second method. The case of the plant owner and his half-million dollar bond issue is contrasted with the first. And which of these two will ultimately become the accepted method cannot at this stage be foretold. So far as the pure mechanics of their handling is concerned, either is practical, though the process of vesting title in the finance company until the final installment has been paid—an essential feature of any installment transaction—is simpler under the second; and this in the end, may gain the second preference.

Under either plan the essential factor, of course, is the suitability of the equipment to its job. When it measures up to that completely and is capable of cutting costs or increasing output sufficiently to earn its cost within the period of the installment contract, the situation is ideal, for in that case the buyer feels no financial strain at any stage of the proceedings. His cash position is not impaired at all by his investment, which carries its own load all the way.

Obviously, it is necessary, in order to insure sound credit work in sales of this kind, to have thoroughly competent engineering counsel approve the plans—a requirement that introduces a new and as yet unappraised factor into installment financing. How dependable such counsel will prove in safeguarding the credit risk involved can be determined only by experience. And the answer to that question will do much to determine how fast this form of credit will develop and what kind of transaction will become the accepted one for its development.

The concentrated risk to the finance company is naturally much greater in any sale wherein the advance to a single purchaser ranges from $10,000 to $500,000 than in the case of an equivalent amount of automobile buyers' paper, distributed as the latter would be among from twenty to one thousand individual purchasers in various localities, in different walks of life and with virtual certainty of nothing worse than an average loss ratio among the lot even in times of depression, because of the protective value of the spread that such paper provides. On the other hand, if the large transaction pays out, the profit is greater because the acquisition and handling costs have been much less per dollar outstanding.

It will not be possible to speak authoritatively upon all phases of this question until the various factors not yet fully appraised have been tested in actual day-by-day experience. The only certainties at this stage are that manufacturers and users of industrial equipment have much to gain by the incorporation of the installment principle into their relationship, that such incorporation is possible, and that the finance companies are bringing it about, testing the various expedients available for that purpose as they go.

Installment Buying Fits Into Modernization Program

At a time when wholesale modernization is indispensable to American industry, the installment principle presents itself as the most practical means of accomplishing this end. As against other methods of financing equipment it offers every advantage to the buyer and while all the problems involved in its adaptation have not yet been settled, it is on its way to a great expansion in the industrial field.

Certain prominent power-plant manufacturers, sensing this trend, have been among the first of all equipment builders to apply it to their products, and the power industry is already blazing a trail for equipment producers in this respect. It is obvious that where one manufacturer or user of equipment leads off in a program of this kind, all must eventually follow or give way, for the producer needs the sales and the user the equipment; and where others have found and utilized a well devised means for bridging the gap, the standpatter is doomed for want either of sales or of facilities, as his case may be.

Will Processed Coal Be the Future Fuel?

No subject today holds more interest for power engineers than the possibility of burning processed smokeless fuels in place of raw coal under their boilers. Some investigators in this field are quite sure that this practice will be universal in the not-too-distant future. Others are led by their studies to doubt if the slight returns to be obtained in this way justify the largely increased investment. Among these latter are Walter R. Knapp and Paul McMichael. A summary of their studies, as carried out for Stevens & Wood, Inc., will be presented in *Power* for April 23.

POWER-EQUIPMENT SCHEDULE

Simplifies Complicated Circuits

The power-circuit schedule described in this article was worked out in the office of J. G. Berger, consulting engineer, Newark, N. J., as part of the engineering work done on the paperboard mill power equipment of McEwan Brothers, Whippany, N. J. In this plant $11,000 spent on reconditioning the boilers, power-generating and distributing equipment saved $28,000 a year in operating costs, as described in *Power*, March 13, 1928. This schedule gives the location of the generating equipment, the motors and the connecting circuits and a record of each circuit, including the conductors' sizes.

WHEN the power-feeder system is extensive, a schedule should be provided as a means of easily identifying the different circuits. Such a schedule should give a complete record of all the circuits in the plant. It should show how the circuits run, the size and number of conductors and whether they are run in conduit or open; if in conduit, the size of the conduit should be specified. Such a schedule should also include the motors, their size and location and what they drive. Other information, such as the location of the motor controllers and switchboards and any data necessary for a complete record of the power circuits, should be part of the schedule.

A power-equipment schedule has many uses. It gives the plant engineers a complete picture of the system the plant is serving. In case of trouble on the system that is reflected back into the power plant, the engineer may notify the repair gang on what feeder the trouble is and what it serves.

No.	Motor Number	Motor Location	Hp.	Make	Drives	Main Feeder Marked	Main Feeder No.	Main Feeder Size	From	To	Branch Feeder Marked	Branch Feeder No	Branch Feeder Size	Size of Conduit	Remarks
1	4	Motor room	150	C.W.	Constant speed No.1	C-1	3	No.250 Mcm.	Switchboard No.4	Control constant speed No.1				3"	
2						C-2	6	No.300 Mcm.	" " "4	Switchboard No.5				Exposed cables	For constant speed No.2
3						M	3	No.4/0	200 amp. 3 P.D.T safety switch	Line M_1 mach room bldg. No.1				$2\frac{1}{2}$"	
4						M_1	3	No.600 Mcm.	Run the length of mach. rm. bldg. No.1	Finishing room bldg.				Exposed cables	Known as motor line
5						B	6	1,000 Mcm.	Switchboard No.1	Beater room 2nd floor				" "	Known as beater line two branches B_1 & B_2
6						J	6	1,500 Mcm.	" " "1	Beater room 1st floor				" "	Known as Jordan line two branches J_1 & J_2
7	33	Boiler room	40	A.C.	Fan in boiler room	S	3	No.1	" " "1	Control in boiler room				$1\frac{1}{2}$"	
8	35	Boiler room balcony floor	15	G.E.	Coal crusher	W	3	No.8	" " "1	Control in boiler room				1"	Motor location on balcony floor
9	32	Boiler room balcony floor	20	A.C.	Coal conveyor	W_1	3	No.6	" " "1	Control in boiler room				$1\frac{1}{4}$"	
10	11	Near swbd. No.5	150	A.C.	Constant speed No.2				" " "5	Control for No.11	$C\text{-}2_2$	3	No.250 Mcm.	$2\frac{1}{2}$"	
32	15	1st floor beater room	150	A.C.	Jordan No.4				Line J_1 to control	Motor No.15	$J_{1\text{-}4}$	3	No. 250 Mcm.	$2\frac{1}{2}$"	
33	16	" "	150	A.C.	" " 5				" " " "	" " 16	$J_{1\text{-}5}$	3	No.250 Mcm.	$2\frac{1}{2}$"	
34	46	" "	60	C.W.	Jordan pumps				" " " "	" " 46	$J_{1\text{-}6}$	3	No.1	Temporary leads	
35	19	" "	50	C.W.	Fresh water pump				Line J_1	Control	$J_{1\text{-}7}$	3	No.2/0	Exposed cables	
36	17	" "	100	A.C.	Jordan No.6				Line J_2 to control	Motor No.17	$J_{2\text{-}1}$	3	No.4/0	$2\frac{1}{2}$"	
37	18	" "	150	A.C.	" "7				" " " "	" " 18	$J_{2\text{-}2}$	3	No.250 Mcm.	$2\frac{1}{2}$"	
38						J_y	3	No.300 Mcm.	Line J_2	Across rm. at col. No.10 to shartle beater control				Exposed cables	
55	26	2nd floor beater room	60	C.W.	Beater No.4				Line B_1 to control	Motor No.26	$B_{1\text{-}3}$	3	No.2	$2\frac{1}{2}$"	Lines for slip rings in same conduit
56	28	" "	60	C.W.	" " 6				" " " "	" " 28	$B_{1\text{-}4}$	3	No.2	$2\frac{1}{2}$"	" " " " "
57	30	" "	60	C.W.	" "8				" " " "	" " 30	$B_{1\text{-}5}$	3	No.2	$2\frac{1}{2}$"	" " " " "
58					" "9				Line B_1	Control	$B_{1\text{-}6}$	3	No.2	Exposed cables	Not connected
59	34	Boiler room	50	A.C.	Fan in boiler room				Line B_1 to control	100 amp 3 P.S.T. switch	$B_{1\text{-}7}$	3	No.1	$1\frac{1}{2}$"	To control in boiler rm. same wire & conduit
60	42	Engine room	40		Exciter				Switchboard No.2	Control for No.42		3	No.2	$1\frac{1}{2}$"	Motor generator set No.1
61	43	Turbine room	50	A.C.	Exciter				Bus of switchboard No.1	" " "43		3	No.2	$1\frac{1}{2}$"	" " " "2

Fig. 1—Feeder and motor data table that goes on the diagram, Fig. 2, to complete the electric-system schedule

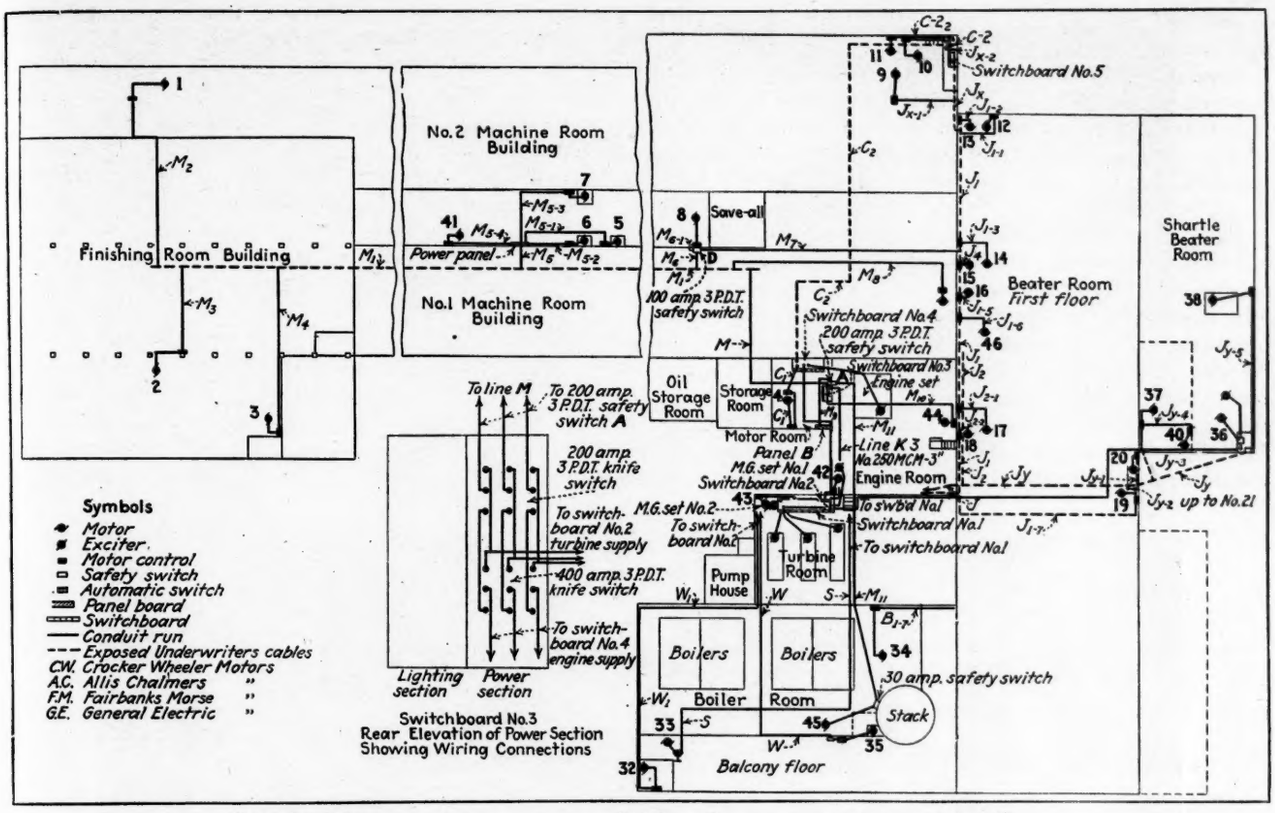


Fig. 2—Diagram of generators, switchboards, motors and connecting lines

On this diagram are included cross-connection instructions which read: Lines *M* and M_1 can be energized through double-throw switch marked *A* 200 ampere, either from switchboard No. 3, or the outside service which enters at panel *B*. On this switchboard two double-pole switches permit the use of either engine or turbine generated current. See drawing of switchboard No. 3.

The double-throw 100-ampere switch *D* enables the Save-All motor No. 8 to operate from either motor line M_1 or Jordan line J_1.

Line *K* from auxiliary switchboard No. 2 takes turbine generated current over to switchboard No. 3 to a double-throw switch on that switchboard.

It is possible to feed back through switchboard No. 3 through line *K* into auxiliary switchboard No. 2 through connecting buses to turbine switchboard No. 1 with power from the steam-engine driven generator unit.

All these cross-connections can be used only to the limit of the capacity of the connecting lines and double-throw switches.

Cross excitation: There is a cross-excitation system of the two motor-generator sets driven by motors No. 43 and 42, one exciter at each of the three turbines, one exciter at synchronous motor No. 36 and one exciter at the engine set. Through a new panel at the right of switchboard No. 1, the turbine and the engine driven generators and the synchronous motor may be excited and emergency lighting may be taken off the two motor-generator sets. These motor-generator sets are connected to the opposite sides of a four-pole double-throw switch.

In the office of the executive engineer or plant superintendent the schedule is useful in discussing matters concerning the power system with the operating engineers. When changes are made in the personnel, the plant engineer may in his office show the new employee the layout of the system. Such a schedule does not leave the organization with the plan of the power system in some one employee's head, who may leave or be incapacitated and cause serious inconvenience until someone has time to learn the system. Where changes are to be made in the power system, a schedule of the circuits gives the information necessary for doing this intelligently.

If the electricians have such a schedule, it will assist in locating trouble on the system. If there is a fault on a feeder that makes renewal necessary, the size of wire can be determined from the schedule. In cases of emergency or a temporary change, what is necessary to meet the conditions can be easily determined from the schedule. A properly arranged power-system schedule will serve a wide variety of purposes and provide a ready means of checking up on any part of the system.

The schedule described in this article is probably a little more complicated than may be required for many plants. It consists of a wiring diagram and a table. If the power system is not very extensive, all the required information may be put on a wiring diagram. On the system in question power is supplied from two power plants, and switchboards are located in five places. The layout of the power system is rather complicated, being the result of a plant expansion over a period of years.

Plans have been made for a complete readjustment of the power system, some time in the future. On the present system there is a connected motor load of about 3,000 hp. These motors range in size from 3 to 150 hp. Power is supplied from three turbine generators in one plant and an engine-driven unit in another plant and is distributed from five switchboards. A connection is made with the local utility lines over which can be supplied about 125 hp. for emergency service.

The schedule as drawn up shows a plan of the buildings, the power generation and feeder system. The beater room has two floors, but only the ground plan is shown in Fig. 2. The floor plan of the machine room has been contracted to simplify the drawing. The data table, Fig. 1, is also part of the sheet on which the feeders are shown, so that a complete record of the power system is on one sheet.

The position of each motor and its control on the system is shown. A set of symbols is included from which may be determined the identity of each piece of equipment. A black oblong shows a motor control, an oblong formed by border lines indicates a safety switch and a cross-hatched oblong represents an automatic switch. Full lines indicate conduit and dash lines show exposed wiring run or insulators. Each motor is given a number and the feeders are identified by letters. These are used

in the data table so that the different items on the table may be easily traced on the diagram.

Special instructions regarding the possibility of cross-connections between the different switchboards and instructions for cross-connection between exciters are also given. These instructions were part of the original schedule, but for simplicity they are shown under Fig. 2, as part of the caption.

Each line in the table gives complete information on a circuit. In this particular case the table includes items numbered from 1 to 61, and these are given in the first left-hand column. The next column records the motor numbers. For example, No. 7 item in the table has to do with No. 33 motor and its circuit. The third column from the left shows that this motor is located in the boiler room, and the fourth column gives the size of the motor as 40 hp. The fifth column gives the make of the motor and the sixth tells that the motor drives a fan. In the exposed, and in the extreme right-hand column the name of the feeder is given as "Motor-Line."

From No. 10 to 61 inclusive, the items in the table are for branch feeders. Take item No. 35, which is for No. 19 motor. This motor is on the first floor of the beater room, it is rated at 50 hp. and drives a fresh-water pump. Power is obtained from line J_1 by a branch feeder that runs to the motor's controller and is identified as line J_1-7. The line consists of three No. 00 exposed wires. All this information is obtained by reading item 35 from left to right in Fig. 1. The spaces under the heading "Main Feeder" have been left blank, as item No. 35 has to do with a branch line and not a main feeder.

On switchboard No. 3, one panel has two double-throw switches that allow connecting the power supply on the turbine-room switchboard with the switchboard in the engine room. Line M can be connected to either power supply from No. 3 switchboard. A connection diagram

Fig. 3—The turbine room of McEwan Brothers Company paperboard mill contains three units having a total capacity of 3,250 kva.

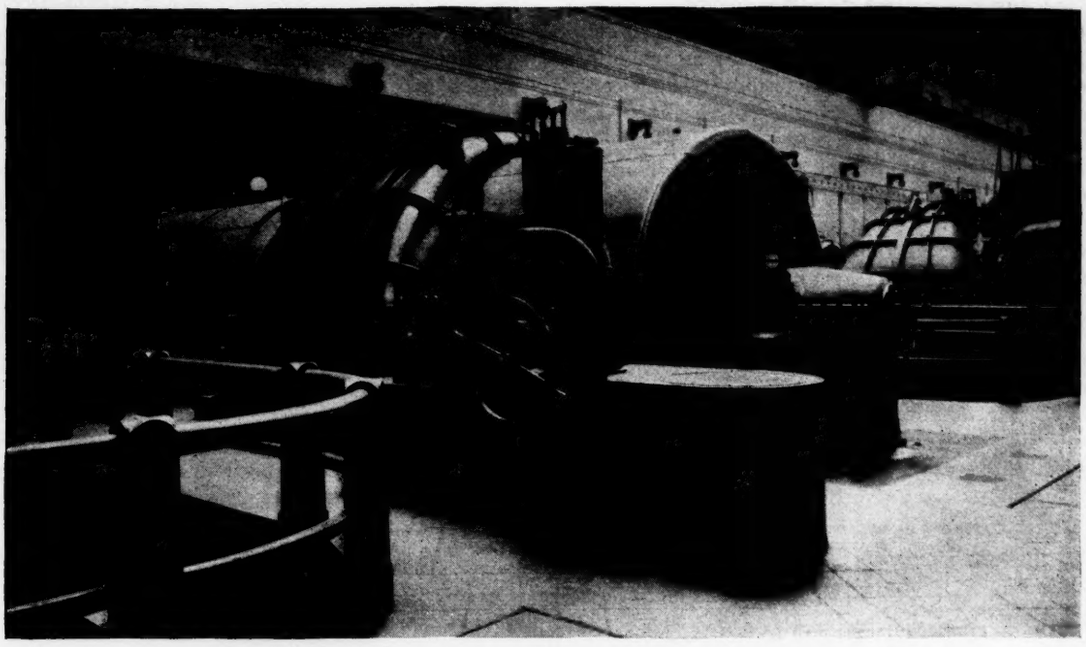
three columns headed, "Main Feeder," we get the information that motor No. 33 is on feeder marked S and that it consists of three No. 1 wires. The next two columns show that the feeder runs from No. 1 switchboard to the motor's control in the boiler room. Next to the last column on the right, headed "Size of Conduit," shows the wires are run in 1½-in. conduit.

Referring to the lower center in Fig. 2, No. 33 motor is found to be installed on the balcony floor in the boiler room, and the controller, indicated by a solid oblong, is on a building column. Feeder S runs from this controller to No. 1 switchboard in the turbine room. The foregoing will answer almost any question regarding the installation of the motor and its circuit, making it unnecessary to go near the machine.

Items Nos. 2 to 6 in the table are for main feeders that supply groups of motors or run from one switchboard to another. For example, No. 4 item is for M_1 feeder, which consists of three 600,000-circ.mil cables. This feeder runs the length of machine room building No. 1, to the finishing-room building. In the columns marked "Size of Conduit," M_1 feeder is indicated as run

is included for the double-throw switches and instructions for their operation.

The schedule described in the foregoing, although not applicable in its entirety to every plant, contains the basic principle for working out a system of circuit records for any set of conditions. A schedule of the system circuits may save its cost many times in an emergency, when temporary provisions must be made to get a machine back into service in a hurry. When the plant is operating normally, there is generally plenty of time to think things out. In an emergency quick thinking must be done, and if it is to be safe thinking, all the data on the problem must be available. A circuit schedule is one way of doing some advance thinking about what to do in an emergency, as well as a means of getting well acquainted with the equipment during normal operation. Any engineer who takes the time to work out a complete circuit schedule of the power equipment in his charge will find himself with a much broader grasp of the job he is responsible for. He may also discover some weak point in the system and changes that can be made at low cost to provide for emergencies.



One of the 40,000-kw. turbines that comprise the No. 4 section at Colfax

Load Dump Tests Made on Colfax Turbines—II

By T. E. Purcell
General Superintendent of Power Stations
Duquesne Light Company

THE article in the preceding number described the changes made on the flyball governors of the 60,000-kw. Colfax units and gave the results of load dumping tests after these changes had been made. This article describes the centrifugal oil-impeller governor on the 40,000-kw. Colfax units and gives the results of load dumping tests.

The No. 4 section at Colfax consists of two 40,000 single-cylinder, complete-expansion turbines. They are bled at four points for feed heating and for evaporating water for makeup.

The governor and valve mechanism on these units differ radically from the other Colfax units in that the governor is of the oil-hydraulic-impeller type and there are two control valves instead of three, the valve chest being mounted on the operating floor.

For several years previous to the design of these units the Westinghouse company engineers had been developing this oil-type governor and had about 150 of them operating on turbines up to 6,000-kw. capacity.

The oil governor arrangement is best shown by the diagram, Fig. 1, which has been altered slightly for the sake of clearness. The main functions, however, are as shown.

Mounted on the end of the turbine spindle is an impeller of 16-in. outside diameter and $1\frac{1}{16}$-in. radial depth. It is supplied with oil at 7 lb. pressure in the inlet chamber. The discharge pressure is 80 lb. at the normal speed of 1,800 r.p.m. The variation in the discharge pressure of this impeller is employed to give the characteristic necessary for stable speed regulation.

Fig. 2 shows, in section, the actual governor impeller. It will be seen that the impeller is radically different in general design from the average centrifugal pump. It is necessary to have a low velocity of oil through the impeller passages in order that the maximum amount of air may be separated, to insure that the density of the oil may be as uniform as possible in order to secure the maximum steadiness of the governor oil pressure. The air that is separated is forced to the inner radius of the impeller inlet, and passes out through the air vent, shown in Fig. 2, to the bearing housing. The impeller is integral with a short length of stub shaft, flanged at one end for bolting to the end of the main turbine spindle. The impeller also is employed as the main thrust collar, there being one set of Kingsbury thrust shoes at each end.

Oil is forced from the main supply tank to the pump

suction by a hydraulic ejector. This ejector is, in turn, operated by the 80-lb. oil supply from the discharge side of the same impeller. The cycle is started by a steam-driven auxiliary oil pump, there being check valves to prevent back flow through the auxiliary pump when the main pump is working, and another check valve to prevent oil flowing back through the main governor impeller when starting. It is important to note that this system eliminates the gear-driven main oil pump found in most central-station turbines. The wear and tear on the driving gear and the attendant mechanism is eliminated, with a consequent increase in reliability and decrease in maintenance.

The governor impeller performs four separate duties. The first, as already mentioned, is the operation of the hydraulic ejector that maintains the impeller suction at a constant inlet pressure of seven feet. The second function is the operation of the sensitive control piston that actuates the main governor relay. The third duty is to supply the variable quantity of oil required to operate the governor-valve power piston. The fourth function is the supplying of oil to the main bearings.

There is a high-pressure connection from the governor impeller to the lower side of the sensitive control piston. As the pressure increases, the control piston, which is formed as an integral part of the main relay, is made to rise against the tension of the governor spring. On the cylindrical portion of the control piston are formed the relay ports, and as it rises, oil is admitted to the top of the main operating piston and discharged from the lower side, causing the main primary valve to travel toward the closed position. As the main valve starts downward, the tapered cam connected to the valve stem actuates a bell crank which, in turn, is connected to the lower end of the governor spring. The tension on this spring is increased and restores the sensitive piston and main relay to the neutral position, thereby bringing the main governor valve to rest in whatever position of equilibrium is demanded by the discharge pressure of the impeller. Thus, it will be seen that the compensating cam can be formed to give a straight-line relation between speed and load, and also that the angle of the cam can be adjusted to give the required full-load to no-load speed variation. The cam and bell crank just described perform the same duty as the usual follow-up motion employed in flyball governor mechanisms.

Instead of having the upper end of the control piston discharged to a free drain, an intermediate pressure of between 20 and 30 lb. is maintained by a small spring-loaded relief valve. Introducing this intermediate back pressure at the upper end of the relay makes possible a simple design of speed changer in which the speed changer motor is arranged to increase or reduce the compression on the relief valve spring, thus increasing or reducing the turbine speed or, in the case of machines

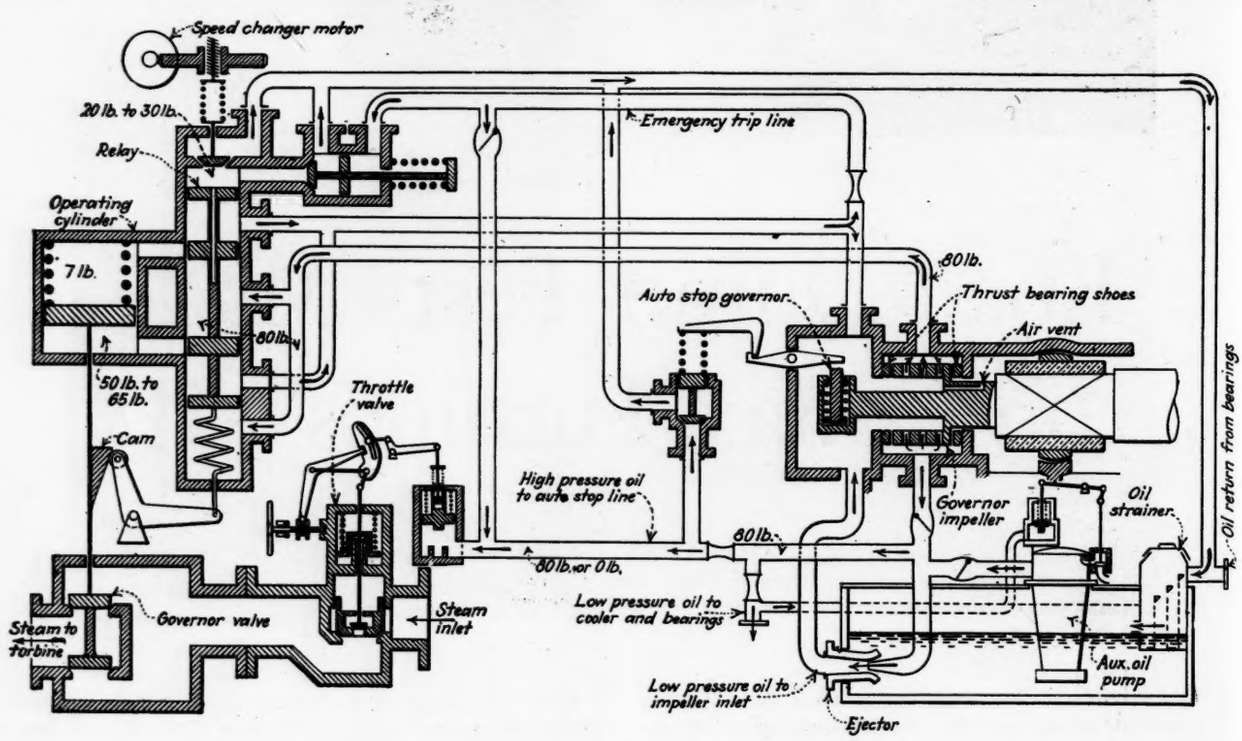


Fig. 1—Diagram of oil governor for 40,000-kw. unit

in parallel, increasing or reducing the load as desired. The speed changer mechanism is equipped with the usual limit switches set at plus or minus 5 per cent for safety.

In order to guard against overspeeding through a failure of the oil supply to the suction of the governing impeller, an emergency trip is employed, which can be seen to best advantage in Fig. 1. A small hydraulic piston is connected to a relief valve, which, in the open position, reduces the pressure on top of the main relay, thereby causing it to move upward to close the main governing valves. When this small low-pressure trip valve is in the closed position, the back pressure on top of the relay is restored and the governor made to function in the normal manner. The emergency low-pressure trip is held in the shut position by the low-pressure oil at the impeller suction pressure passing through an orifice to the control piston. In the event of the impeller suction pressure failing, the low-pressure trip will operare to close the main governing valves.

For many years it has been common practice to employ a steam-operated trip system for the purpose of closing the main throttle valve at a specified overspeed. On the No. 4 unit oil has been employed as the operating medium, as shown in Fig. 1. The use of oil in the throttle trip system eliminates the possibility of the trip gear parts sticking, because of an accumulation of scale or corrosion. The arrangement is such that in the event of the automatic stop governor coming into operation, the main governing valves are closed, as well as the throttle valve. This is done by the interlocking connection with the low oil-pressure trip system.

In addition to the safeguards previously mentioned, the steam-driven auxiliary oil pump is provided with a hydraulic governor controlled from the bearing line pressure, which, on these turbines, is maintained at 12 lb. Should the bearing pressure drop below 9 lb., the auxiliary oil pump starts automatically supplying oil to maintain the governor system at the operating pressure, and in addition providing a sufficient supply for the bearings.

In the foregoing, repeated reference has been made to the diagram in Fig. 1. In the actual steam-chest construction shown in Fig. 3, the various parts can be traced by a comparison with the diagram. The secondary valve is operated through a linkage that can be adjusted to pick up the operating lever at the desired load. The compensating cam is formed so as to secure a smooth governing curve when the secondary valve is opening.

Using the equipment developed for testing the governors on the 60,000-kw. units, load dumping tests were

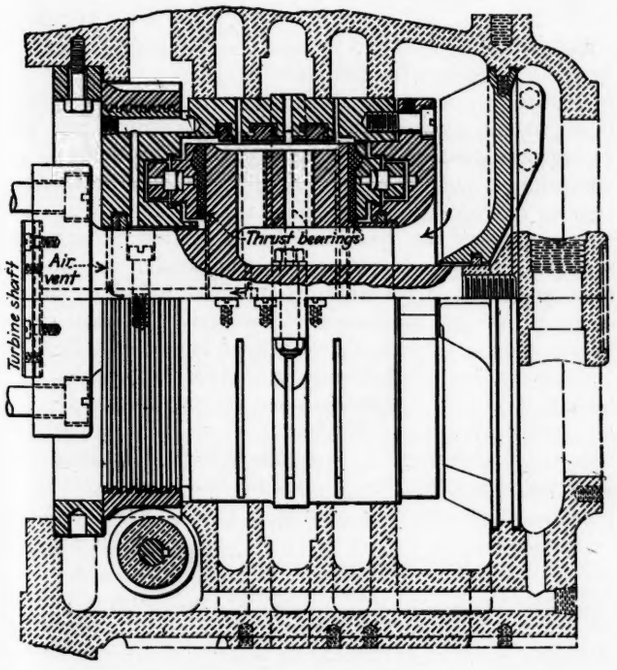


Fig. 2—Section through oil governor impeller and thrust bearing

also made to determine the characteristics of this type of turbine governor. The results of these tests are shown in the curves of Fig. 4.

The jump in speed reached a maximum of about 8.9 per cent above normal. In this connection it should be appreciated that this is the first installation of large central-station turbines with oil governors on which critical operating limits have been imposed. As a result, the manufacturer was forced to carry out some amount of research to obtain satisfactory stability and prompt response for emergency conditions.

It was found necessary to increase the speed variation to 5.5 per cent in order to secure stability. As a result

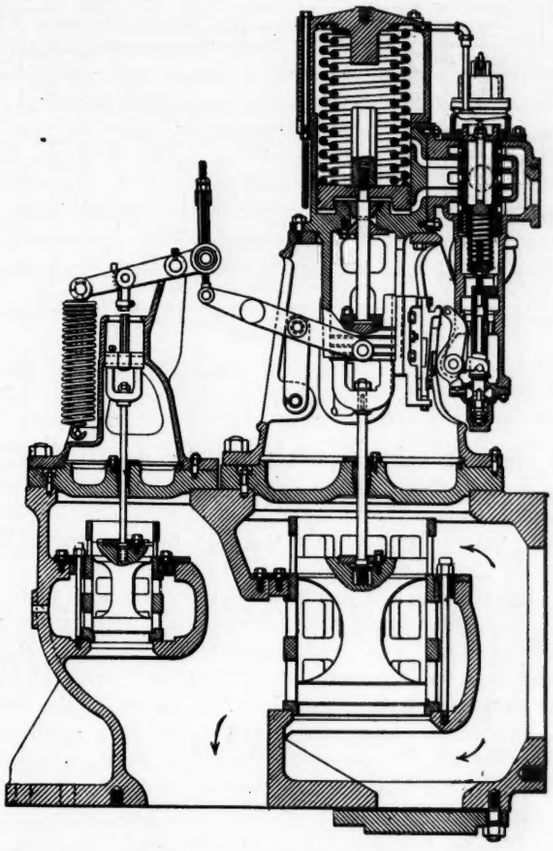


Fig. 3—Steam-chest assembly, 40,000-kw. unit

of this the maximum speed jump was somewhat increased. For the operating conditions at Colfax there is no objection to the 5.5 per cent speed variations. Neither is there any objection to the 8.9 per cent upper limit of speed during the load dumping tests. These things are mentioned, because it might otherwise seem, from a superficial glance at the test results, that the oil governor has not met the performance record established by the flyball governor. There is every reason to believe that, in future oil governors, the speed variation can be maintained at 4 per cent with adequate stability, while at the same time the mechanism will have the desired quick response.

The No. 3 section consists of two single-cylinder, single-flow, complete-expansion 35,000-kw. turbines. Steam is bled at four points in the same path for feed heating and for evaporating water for makeup.

When these turbines were first placed in service, they were equipped with the standard fly-ball governor, differing only in minor detail from the original governors on the 60,000-kw. units. Changes, similar to those made on the 60,000-kw. units reduced the speed jump of this unit to 7.1 per cent above normal speed. So far as known this is the best governor performance on large central-station turbines that has been demonstrated by actual test.

Much has been written concerning the need of check

valves in the steam connecting pipes between the heaters and the bleeder openings in turbine cylinders. Some interesting load dumping tests were conducted on the 35,000-kw. turbines, to determine the additional overspeed caused by the steam trapped in the heaters and the steam that might re-enter the turbine from the evaporator connection. These turbines are bled at four points,

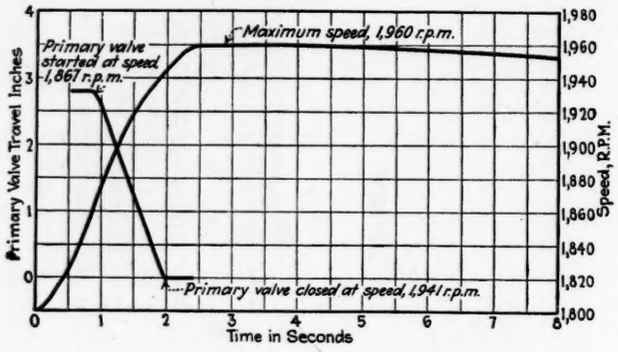


Fig. 4—Performance of oil impeller governor during load dump test

the pressures being approximately 125 lb., 50 lb., 12 lb., and 5 lb. absolute in the four bleeder zones at the most efficient load. As originally installed, there were no check valves between the turbine bleeder connections and the heater or evaporator piping.

After the quick-response valve gear had been installed, tests were first made to determine the speed jump with the heaters and evaporator open to the turbine. It was found that the maximum speed reached about 13.5 per cent above normal. By closing the valves in the heater and evaporator lines, the speed jump was reduced to approximately 7.1 per cent. In other words, the steam trapped in the heaters and evaporator was sufficient to increase the speed jump by almost 7 per cent.

It further developed that the trapped steam in the two lowest temperature heaters was not sufficient to increase the overspeed a perceptible amount, but that practically all of the increase came from the steam in the two highest-temperature heaters. As a result of these tests, check valves were installed between the two high-temperature heaters and the turbine bleeder openings.

This investigation, which took nearly two years to complete, was carried on jointly by engineers of the Westinghouse Electric & Manufacturing Company under R. C. Allen, and of the Power Stations Department of the Duquesne Light Company.

One of the best compounds for cleaning grease and other deposits from an air compressor and connections is a strong solution of ordinary brown soap and water, introduced at the intake valves or forced into the indicator connections of the air cylinder with a hand pump while the compressor is running. If the cleansing is to extend no farther than the receiver, close the delivery valve of the receiver and discharge the dirt and suds through the receiver drip cock or valve. The air line can be cleaned in the same manner by closing the receiver drip and opening the receiver discharge valve after compressor and receiver have been cleaned. Thorough cleaning usually results in removal of not only the grease, but also the smooth graphite-like surfaces of the air cylinders, and for several days after cleaning plenty of lubricant should be supplied to the cylinders.

Points to Consider in Treating Feed Water

By Captain H. C. Dinger

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THE points to consider in determining arrangements for conditioning feed water are:

A. Removal of air and corrosive and scale-forming ingredients from the feed water by such means as the available capital for investment in apparatus will permit. This involves distilling, pretreatment, filtering, etc.

B. After-treatment to correct conditions that have not been entirely overcome by the means mentioned in A. Such treatment may be at times almost nothing; but, in case of failure of condenser tubes or some other unlooked-for development of a source of contamination, it may be suddenly necessary.

C. Proper blowdown procedure to eliminate collections of solids and sludge and to reduce concentrations of impurities in the boiler.

The character of the pretreatment and of the after-treatment will depend upon the kind of feed and plant conditions. If waste steam is available, distilling is usually justifiable, as the cost of the distilling apparatus is not great and, if properly connected in with the feed-heating arrangements, the cost of operation is almost trivial. It is not advisable, however, to depend entirely upon distilling or pretreatment apparatus, since neither of these may give an entirely uncontaminated water. Condenser leakage and other causes may at times be rather serious, and a certain amount of after-treatment controlled and regulated by analysis and tests is essential in order to secure the best results.

The reduction of the air content of the feed to boilers is important, particularly where high pressures and high ratings are used, and no system of guarding boilers from corrosion is complete without giving suitable consideration to extracting or excluding the entrained air. The entrance of air can be reduced to a minimum by having a sealed or closed system for the condensate and by making provision for deaëration, either in the condenser of by fitting special deaërating heaters. In small plants where special deaërating apparatus is not installed, air content can be reduced by venting feed heaters and feed lines installing air separators and by exercising care that air is not allowed to be drawn in or to mix with the feed or condensate. Air may be drawn in by reason of condenser leakage, leaky suction lines, and glands on pumps, and by surface mixing is feed or hotwell tanks.

Condition of Makeup Feed

The percentage of makeup and the natural condition of the water are important factors in determining whether distilling, external treatment or internal treatment should be used. Where very large amounts of water are required and where an effective external treatment can be provided with fairly low operating costs, the special water-conditioning apparatus may be more economical than a distilling plant. Where the amount of makeup feed is small and the raw water of such nature that pretreatment is difficult or expensive (as would be the case with sea water or very hard water), distilling would be more advantageous. Where the water is soft and contains only a small amount of scale-forming ingredients, only internal conditioning may be justified. However,

there is hardly any natural water supply that is not contaminated in some way, and many waters entirely fit for domestic purposes should have some treatment or conditioning if they are to be used in high-pressure boilers. It is usually much easier and less expensive to remove or correct the contamination before than after the water has been evaporated.

Application of Protective Surface Film

Recently, methods have been evolved of producing a protective film upon the surface of the metal, which remains there; and from which scale, rust and dirt deposit can be more easily brushed. The film protects from corrosion; but, owing to its smooth surface, it also prevents the scale and dirt from depositing upon the metal itself and makes this scale formation less adherent and more easily removed by circulation, by the action of boiler reagents, or by cleaning brushes. These thin film surfaces also do not appear to detract from the heat transfer; but, owing to the smoothness of the surface, apparently create mechanical conditions which improve the steam forming ability. It is more or less generally recognized that a smooth and polished surface will be more effective in evaporating water than an irregular one.

The methods of applying this film protection to boiler heating surfaces are still in their infancy, but several have been applied successfully. There are two general ways of obtaining the film. One is by direct application of the coating to the cleaned surface by spray or by means of brushes. "Apexior" is an example of this. This particular compound is being applied with considerable success, and when carefully applied and periodically reapplied where film has been penetrated in spots due to presence of some foreign material on the metal surface, it does furnish protection, particularly from air or oxygen corrosion. Great care must be exercised in applying it, and it works properly only when applied to an entirely clean surface. It appears, however, to be practical to secure such surfaces without unreasonable trouble and expense. A different way of securing such a protective film is by means of some ingredient fed in solution to the boiler feed.

Silicate of soda will produce a film that will give some protection or stop slight leakage. It seems to operate very well in cold water and has been used effectively in domestic water systems. It definitely deters the formation of salt scales; hence, it is useful in evaporators and in boilers where scale-forming salts may be present. Various colloids recently used in connection with feed-water treatment, also, under the correct chemical control, will produce this protective film. Sodium alginate has been found to do this in certain cases. This film has been produced by the use of "Algor," which makes use of a special form of "Algin." Special briquets or mixtures using tri-sodium phosphate and sodium alginate may produce similar results.

It is quite likely that there are other colloids that will, under certain conditions, produce this effect, and that some chemical research, investigation and tests will in a short time develop fairly definite means of chemical control, so that such protective films can be produced at will.

It is, however, very likely that this film protection, like the mechanical application of a protective coating, will be produced in a satisfactory manner only where the metal surfaces are clean and free from mill scale or when introduced with other reagents that first clean the surfaces.

Whether these films can be produced for any varying range of temperature does not yet appear to be known definitely. We know that under favorable conditions protective films on the water surface of boiler tubes can be produced. With a little more experience and experimentation, it is likely that this can be definitely controlled and that the particular conditions for producing them on a new boiler can be determined.

This being developed, the obvious practice would be to clean new boilers thoroughly of all mill scale, mechanically boil out and then operate them at first with relatively high alkalinity to remove everything but the metal, and then build up the protective film by means of the proper reagents added to the feed water. This being done, the life of the tubes should be materially increased and the steaming capacity as well. In particular places where pitting and the presence of air are noted, a coating of some preservative paint would be helpful in affording protection.

Alkalinity or pH Control

It should be recognized that the pH control and the control of the sulphate-carbonate ratio (where needed) are more accurate and more scientific than the alkalinity control expressed variously as so many degrees of alkalinity, so many parts per million or so many grams per gallon. However, the ordinary alkalinity control gives satisfactory results in most cases, and the alkalinity can be determined by means of simpler apparatus and less skillful or trained operatives. Where apparatus and feed-water experts are available, pH control may give somewhat more accurate results and enable a more exact control to be exercised.

A.S.M.E. Committee Reports

The information and opinion presented in connection with the activity of the A.S.M.E. Committee of Boiler Feed Water, as published in the May-August, 1928 Transactions of A.S.M.E., give interesting information concerning opinions and experience of experts. If there is one definite valuable lesson to be learned from this, it is that where any complication or uncertainty as to feed water is presented, the advice of a feed-water chemist should be sought. Anyone having feed-water problems should not fail to read this matter, as there are numerous examples of practical experience guided by knowledge of the chemistry of feed water and boiler operating conditions which show that there are no cure-alls and that each particular problem should receive expert attention and that chemical knowledge, as well as engineering knowledge should be used. If this is done, practically any feed-water problem can be handled in a satisfactory manner.

Causes of High Head Pressures

High head pressures in a refrigerating plant are caused by air or foul gas in the system, a condenser, badly scaled on the water surface, oil in the condenser, or by some of the condenser coils being blocked. In a double-pipe condenser the water pipes are readily scaled. The annular space between the pipes is small, and this sometimes blocks with oil, scale and other foreign matter. Generally, if this happens a number of the stands will be cold, and by going along the condenser and feeling them, the "dead" ones can be located. These should be shutoff, with the water running on them for a few hours and then purged.

Sun Spots a Factor in PREDICTING S

By A. Streiff
Jackson, Mich., Office.
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Research based on the frequency *of sun spots cycle.. the thickness of ring growths on trees, the rise and fall of lake levels and other phenomena gives promise of tangible results in predicting stream flow. The author of this article has done extensive work on the problem of predicting stream flow and has made advance estimates that closely approximate the actual flow. In this article the problem is outlined, the factors that influence rainfall are given, and it is shown that stream flow can be predicted well in advance of its occurrence. A second article will deal with run-off records.*—Editor.

According to the United States Geological Survey water-power plants in this country supplied about 35 billion kilowatt-hours, or about 40 per cent of the power produced in 1928 by public-utilities. Variations in the flow of streams cause fluctuations in this source of power that run into important figures. In Michigan, during 1928, 1,143,397,000 kw.-hr. was generated by hydro-electric plants. If the water in that year had been as low as in 1925, the output would have been reduced about 400,000,000 kilowatt-hours.

Such large hydro-electric power variations constitute a considerable element of uncertainty when planning for future power requirements. The rate of increase in demand is known within sufficiently close limits. If, however, in a combined hydro- and steam-power system the former is subject to indeterminable annual fluctuations amounting to 30 per cent or more, proper provision for future expansion will be rendered more difficult. This uncertain element in water power must be met by a margin of safety in steam power which necessarily represents additional investment without adequate return.

These unexpected changes are not uncommon occurrences in public-utility management. Construction on a hydro-electric plant was started in 1917 and estimated to cost $2,500,000; eventually, it was completed at a cost of $5,000,000. In addition, the two years following the plant's completion were exceedingly dry, seriously curtailing output and causing financial embarrassment. A similar case is now occurring in a different part of the country. Another utility, fearing continuation of the dry years culminating in 1925, hurriedly spent large sums to increase its steam power. But the hydraulic output increased sharply in 1926 and the new investment was superfluous for the original purpose.

In the financial section of the daily press it was recently stated that water power in the United States is now gaining on steam power, the percentage of water power being, in 1923, 34.8 per cent and in 1928, 39.6 per cent of the total. It should not be concluded that hydro-electric plants are being built at a greater rate than steam power plants. The increase in hydro-power is due to the year 1923 being extremely dry in many sections of the country, while 1928 was a wet year.

In many fields of human activity variations in streamflow play an important rôle. Agriculture may be seriously affected by variations in rainfall and run-off. Interior navigation is greatly affected; the value of one foot additional draft in the harbors of the Great Lakes is placed at $6,000,000 annually. Real estate values are influenced by advancing and receding shore lines. Ground-water levels change, varying the output of wells for domestic industrial water supply. In the arid West changes in ground-water levels are often of great importance. With ground-storage empty, considerable rain has little influence on run-off, while in the reverse case moderate rainfall may cause destructive floods.

Science has been aware of the existence of trends and variations in weather and climate. An extensive literature on climatic changes exists, tending to prove that climate is subject to short and long changes. These changes are partly due to apparently inseparable causes and tend to follow definite trends.

Evidence of Climatic Changes

Evidence of such climatic changes is abundant and conclusive, beginning in early geological time and continuing up to the present. Thus evidence exists of an extensive glaciation having occurred early in the coal age, a geological period distinguished by the abundance of tropical vegetation. The polar expedition of Nares found about 50 years ago, in the lower carboniferous rocks in 74 to 76 deg. latitude, fossils of luxurious tropical vegetation. In the limestone on the north shore of Grinnell Land (83 deg. latitude) corals and cephalopoda of tropical origin were found.

Thus, at the poles a warmer climate has left evidence of its existence. At another time, estimated as recent as 12,000 years ago, the polar cap extended as far south as Long Island and Ohio. The great Agassiz Lake stretched far across the present Great Lakes region. In the Great Basin of Utah and Nevada the Pleistocene Lakes Bonneville and Lahontan occupied an immense area, and have shrunk to the present Salt Lake and the Walker, Winnemucca and Carson Lakes.

Such climatic changes took place very slowly and probably still do so. By measuring the annual clay layers left by the receding glacier in the Connecticut River valley, geologists have determined the rate of recession of the ice edge. The retreat from Hartford, Conn., to Innwood, Vt., lasted 4,000 years. After the ice disappeared, a considerable amelioration of climate occurred, resulting in higher temperatures than exist at present. Remains of mollusks, now found only south of Cape Cod, have been found in Casco Bay, Me. Marine shells found near Boston grow now only south of the Virginia Capes. Mastodons and mammoths were frequent in the East and Middle West during the retreat of the ice. Professor Antevs states that the post-glacial climatic changes were similar in North America and Western Europe.

Rainfall, too, has left evidence of its changes. On the Island of Skyros, in Greece, fossils of Rhododendron

STEAM FLOW *for Power Generation*

The Author Says . . .

We can no longer proceed on the basis of a chance sequence of rainfall. The solar cycle can be estimated in an approximate manner years ahead, and the run-off cycle in many localities is therefore also subject to estimate a long time in advance. It might seem rather a far cry from astro-physics to engineering, were it not that an association of the two sciences has been effected before. Helium, first discovered in the solar spectrum, is now applied in aëronautical engineering. In the same manner we find that the data collected on solar variations prove directly applicable to the problem of power supply from hydro plants.

have been found, a plant requiring greater moisture than is available there at present.

Also, for historic times, abundant evidence exists, if not of permanent changes, nevertheless of important fluctuations in climate. Professor Huntington ascribes the march of civilization northward to a progressive decrease of rainfall in Mesopotamia and the Near East and the amelioration of climate in northern Europe. The late Sir William Wilcocks, director-general of irrigation in Egypt, who partly rebuilt the ancient irrigation works of Mesopotamia, relates how on his explorations of the desert he rode for miles over fragments of broken pottery, indicating a once flourishing population. Looking over the ancient maps of Ptolemy, the multitude of towns, villages and hamlets shown in North Africa and other regions now barren deserts, is striking. Professor Huntington concludes from the ruins of Pueblo Grande de Nevada that the moisture must have been greater than at present to enable the existence of such a population as is evident from these ruins. In now ice-filled valleys of Greenland graves have been found dating from Norsemen settlements and penetrated by roots of trees. Large trees, once found in Iceland, no longer grow there.

At present evidence of climatic oscillations still occurring is furnished by lakes and glaciers. In 1847 the Vernagt glacier in Tyrol grew so much during a wet period, the thunder of masses of breaking rock and ice was heard incessantly and the movement of the ice was visible to the naked eye. Professor Bruckner found in 1890 that the Hohe Tauern glacier in the Alps had reduced in area 20 per cent since its previous greatest extension. The Great Salt Lake in Utah, once 19,750 square miles in area, as is plainly evident from the ancient beaches still found in the desert, increased 420 square miles in area from 1850 to 1869. Lake George, in New South Wales, discovered in 1820, was 18 miles long, 6.25 miles wide and 26 ft. deep. In 1836 travelers found that this lake had entirely disappeared. In 1852 water ten feet deep accumulated in its basin after which it dried out once more. In 1860 water began to accumulate in the lake's basin again and in 1874 attained its previous area of some 100 square miles and a depth of 26 ft. The similarity of movement of Lake George and the Great Salt Lake is shown in Fig. 1.

The Great Lakes, having an outlet, are not subject to such extreme variations. A minimum level occurred in 1819 and a maximum, 6.6 ft. higher, in 1838. Another minimum level was reached in 1925, while since then a considerable rise has taken place. This furnishes evidence that the lowering of the Lake levels prior to 1925 was due to a climatic change and not to the influence of the Chicago drainage canal.

River-Flow Fluctuations

The occurrence of climatic changes in recent times was carefully investigated by Edward Bruckner, late professor of geology at the University of Vienna, in a work published in 1890, and entitled "Climatic Changes Since 1700." In this work he compiled and analyzed 36,900 observation-years of 804 stations. From this immense material he concluded that 25 climatic oscillations have occurred since 1000 A.D., having an average length of 35 years, but varying from 25 to 50 years.

From recent works on climatology the engineer learns that although ceaseless changes, previously referred to, are confirmed and extended, no definite laws have been established. It is also held that as far as practical application on daily problems is concerned, no definite rules or methods have been offered that could be followed by the engineer. The application and extension of the findings previously mentioned, therefore, constitute a virgin field of research and have attained important proportions, principally due to the importance of hydro-electric power. While a great deal of scientific research has been made on the fluctuations of atmospheric pressure, temperature and rainfall, practically no investigations of the fluctuations of river flow are available.

It would be of great benefit to have advance knowledge of river-flow fluctuations. It should be possible to estimate these changes in advance of their occurrence, with a reasonable degree of accuracy, in order to strike a bal-

ance between supply and demand of electrical energy. Such determinations would be possible if separable laws could be found which govern run-off. Stream flow is influenced by so many factors, each of which seems to vary, that few attempts have been made to isolate, if possible, some of the causes and to estimate their effects. On the contrary, the usual procedure is to regard these causes as being inseparable and the resulting run-off wholly as a matter of chance. The assumption is indeed tempting, for run-off is the result of rainfall, evaporation, vegetative cover, transpiration, topography and surface geology. The first-named is dependent on temperature, cloudiness, solar radiation, humidity, wind velocity and barometric pressure. Each of these factors is highly variable, hence the result has been regarded as a fortuitous sequence subject to the laws of chance. The occurrence of a dry year next year is supposed to have the same probability now as at any other time.

Adopting such a viewpoint, determinations of maximum and minimum conditions have been made, based on extrapolation of frequency curves. In other words, any value of flow might occur at any time, though with decreasing frequency as we depart on either side from the mean value. Adopting certain limits of flow from a short record, artificial records based on chance drawings, as in lottery, have been proposed and conclusions for required storage capacities derived therefrom.

However, a hypothesis of stream flow being subject to fortuitous fluctuations only is at variance with the facts.

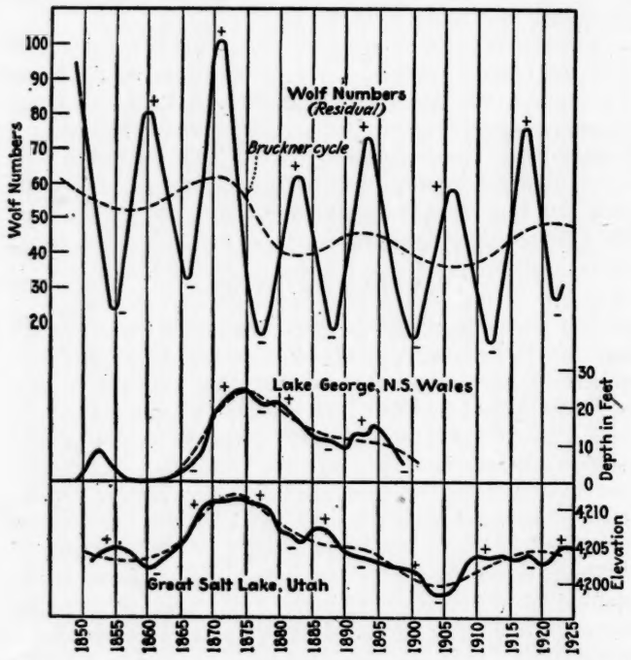


Fig. 1—Lower curves show variation in lake levels, and the top curve indicates the eleven-year cycle of the sun's spots

Wolf numbers are an index, introduced by the late Professor Wolf, to measure the relative abundance of the sun's spots.

Though dependent on many variable causes, there are many indications that stream flow follows definite trends far better discernible than in rainfall, temperature and barometric pressure. While a rain gage is a mere point in space, the large drainage areas of rivers equalize many of the fortuitous fluctuations and ground storage equalizes some more. Many variations can be sifted from the data before we have a remainder that seems to be wholly accidental.

The late Professor Bruckner did this to a considerable extent, and it is on his researches that we can build a conception of stream flow directly applicable to the exigencies of modern public-utility management. Bruckner found the existence of dry, warm periods alternating with cold and wet ones in swings of unequal length but averaging 35 years. As a matter of fact, the last two periods have been only some 25 years in length. The

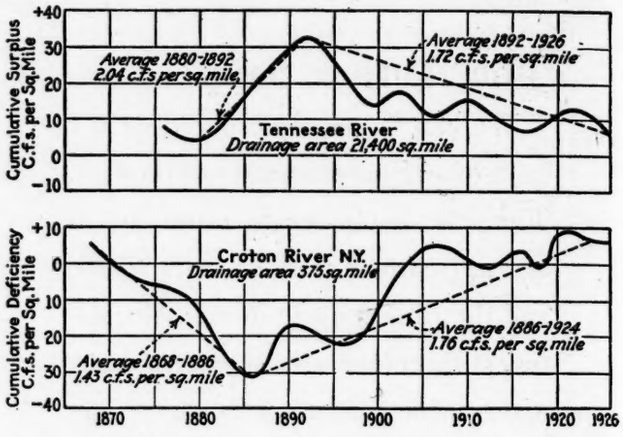

Cumulative Surplus C.f.s. per Sq. Mile
Average 1880-1892 2.04 c.f.s. per sq. mile
Average 1892-1926 1.12 c.f.s. per sq. mile
Tennessee River
Drainage area 21,400 sq. mile
Cumulative Deficiency C.f.s. per Sq. Mile
Croton River N.Y.
Drainage area 375 sq. mile
Average 1868-1886 1.43 c.f.s. per sq. mile
Average 1886-1924 1.16 c.f.s. per sq. mile

Fig. 2—Mass curves of long run-off records for the Croton River, N. Y., and for the Tennessee River

isotherms alternately travel north and south over a distance of some 200 miles. These periods will not be uniformly dry or wet for smaller cycles occur, but the wet period will have two wet years out of three and the dry period one wet year out of three. The same short fluctuations exist, but the mean has changed to a different level, and it is this mean which causes the effects previously mentioned.

Segregating the various cycles can be assisted by searching for a correlation with other phenomena, which in turn may be better known or better estimated in advance than the changes of stream flow themselves. Run-off depends primarily on rainfall, and this in turn on the general circulation of the atmosphere. The earth's atmosphere is actuated principally by solar radiation. Reducing the earth to the size of a twelve-inch globe, that part of the atmosphere containing cloud formation would be represented by a mere film one sixty-fourth of an inch thick. In such a thin film a difference of equilibrium between two localities is equalized only gradually. Hence, daily and yearly periods in atmospheric circulation due to similar changes in exposure to solar radiation are in evidence in meteorological data. These changes are due to the orbital motion and rotation of the earth. For other changes, not accounted for in this manner, we naturally look for a correlation with changes on the sun itself.

It might seem rather a far cry from astro-physics to engineering, were it not that an association of the two sciences has been effected before. Helium, first discovered in the solar spectrum, is now applied in aëronautical engineering. In the same manner we find that the data collected on solar variations prove directly applicable on the problems of power supply from hydroelectric plants, on account of their dependence on river flow, which in turn follows climatic changes, the latter apparently often in agreement with solar variations.

Direct measurements of changes of solar energy are available only for very recent times. Much older records exist, however, of the visible disturbances known

as the sun spots. These cyclones in the solar atmosphere have at times been so large and numerous that they have been visible to the naked eye. The rays emitted by these solar cyclones reach far out into space and cause disturbances in the earth's atmosphere. Northern lights burst forth with great splendor, magnetic storms occur, and there is a general increase in storminess. On account of the close relation with aurora borealis, sun spot maxima can be traced far back into history by the records of exceptional display of aurora. Also, the historical records of the wine harvest and the occurrence of exceptional hailstorms frequently permit some, though less definite, conclusions.

Fabricius first detected by telescope, in 1610, the normal existence of sun spots, and the first maximum was accurately determined in 1626. Data previous to that time are taken from old Chinese observations, supplemented in part from European records carefully collected by the late Professor Wolf, who introduced an index to measure their relative abundance, called the Wolf numbers. Henry Hudson, on that memorable journey of the "Half Moon" in 1609, records the appearance of visible spots. Intense Northern lights have occurred on numerous occasions throughout the Christian era, enabling fixing the dates of maxima fairly accurately. Such outbursts were visible in Portugal, Palestina and Syria.

Accurate quantitative records of the Wolf numbers do not exist farther back than 1749, and naturally increase in accuracy as we approach modern times. If we now desire to find some relation between hydrographic phenomena and solar variation, we are confronted with the difficulty that our records of river flow are much shorter than the record of the Wolf numbers. The spottedness of the sun is now regularly observed at the Mount Wilson, Harvard, Yerkes and United States Naval observatories and the results monthly printed in the United States publication, *Monthly Weather Review.*

Wolf Numbers Cycle

The principal characteristics of the Wolf numbers is their fluctuation in cycles of about 11.2 years. It has been established without doubt that especially in the tropics the 11-year cycle is noticeable in meteorological data, but in higher latitudes it is not so easily distinguishable. Hence Professor Bruckner, working with five-year averages, failed to find the direct relation apparently existing between his climatic cycle and the Wolf numbers. But it can be shown that the Wolf numbers and their 11.2 year swings move gradually to higher and lower averages in longer cycles, and these longer fluctuations appear to be unmistakably in parallel with Bruckner's curves (see Fig. 1).

The agreement does not rest there, but can be traced also to cycles shorter than 112 years. This relation is, however, by no means everywhere existent. A stone thrown into a quiet pond will set up a series of concentric and symmetric waves, but under the influence of a sloping beach the latter's irregularities will give rise to numerous secondary waves and ripples. Likewise, the normal circulation of the atmosphere will be greatly modified by the division into continents and oceans, plains and mountain ranges, and other features of physical geography. Hence the relation, clear and faithful for some regions, shows greater dispersion for others, and often the effects are reversed. Bruckner already noted a reversal of conditions over the oceans from those prevailing on the continents, the oceanic conditions extending also over the coastal regions. This is evident from Fig. 2, which shows an opposite trend for the Croton River watershed as compared with the Tennessee River.

The cause of this change in phase is further explained by a discovery made by Doctor Kullmer. By counting the storm tracks shown on the United States weather maps crossing a certain locality, it was found that these storm tracks shift their course with the solar cycle, and the maxima of precipitation occur therefore in different localities at different times. The process might be compared with the different routing of a sprinkling wagon, some localities receiving their maximum share of precipitation years later than others. But in addition other causes are at work, which also seem to vary the opening of the spigots in long intervals. Such long cycles may occur simultaneously in this country with those in the antipodes, as is indicated in Fig. 1, where the similarity of the long-time variation in the level of lakes in Utah and New South Wales is plainly shown.

Since the previously mentioned relations do exist, we can no longer proceed on the basis of a fortuitous sequence of river flow. The solar cycle can be estimated in an approximate manner, years ahead, and the run-off cycle in many localities is therefore also subject to estimate a long time in advance. The conception, based on chance occurrence, of any stream flow being possible at any time becomes an absurdity.

[*In the next article the author will discuss some of the facts, chosen at random, which refute the conception of stream flow being a chance occurrence. He will examine evidence covered by figures used by engineers and applicable at the present time.—Editor*]

Lamp Cleans Blackening from Inside of Bulb

BULB blackening has always been a significant factor in determining the useful life of all incandescent lamps, and owing to the large filament in high-intensity gas-filled lamps the factor has been most important. The rising gas in such a lamp carries along evaporated tungsten, which is deposited on the cooler top and sides of the bulb. This tungsten soot absorbs considerable light and radiates heat. In time the glass undergoes devitrification and finally becomes so hot that the bulb is deformed and is useless.

The development of a practical method for removing the black deposit that gradually collects on the inner surface of high-powered incandescent lamps has been announced by the Lamp Development Laboratory of the General Electric Company, Cleveland.

The new deposit-remover is a tablespoonful of coarse tungsten powder placed inside the lamp before it is sealed. After the lamp has become blackened from use, the operator needs but to remove it from its socket, invert it and sweep the filament deposit off the inner glass surface by shaking the lamp. The lamp is thereby restored to its former efficiency, as good as new. With the bulb-blackening difficulty practically removed, the lamp filament may be heated much nearer to its melting point without endangering the bulb and without shortening the customary 100-hr. life of the lamps.

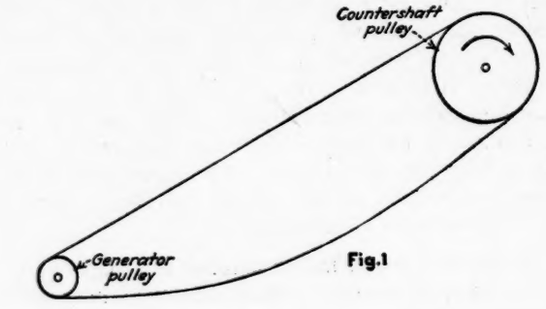
The new method for cleaning the inside of the bulbs has been applied to several high-intensity lamps, including the 1,500-watt 32-volt, the 3,000-watt 32-volt, the 5,000-watt 115-volt, and the 10,000-watt 110-volt lamps for aviation service; and the 5,000- and 10,000-watt 115-volt lamps for motion picture studios.

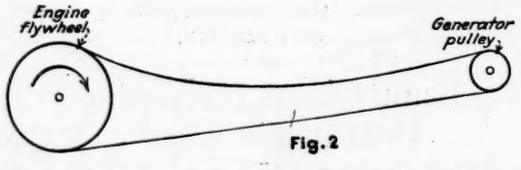
Right Out of the Plant

Rearrangement of Generator Drive Cuts Costs for Purchased Current

A SIMPLE change in the arrangement of a drive made recently in an industrial plant is saving the owner around $100 a month for purchased power as well as conserving considerable space in the plant.

With the drive as laid out originally, the engine was belted to a countershaft, which in turn was belted to the generator with the drive arranged as shown in Fig. 1.





Original and improved generator drive

In this drive the slack side of the belt was on the bottom, with the result that a load of only 40 amperes could be carried instead of the full load of 100 amperes.

In the new arrangement of the drive the generator was located so that it could be belted directly from the engine pulley with the slack side of the belt on the top, as shown in Fig. 2. Now the full load can be carried on the generator without any trouble. Consequently, there is a big reduction in the amount of current purchased from the local utility company.

Quincy, Mass. C. RICHARD WARD.

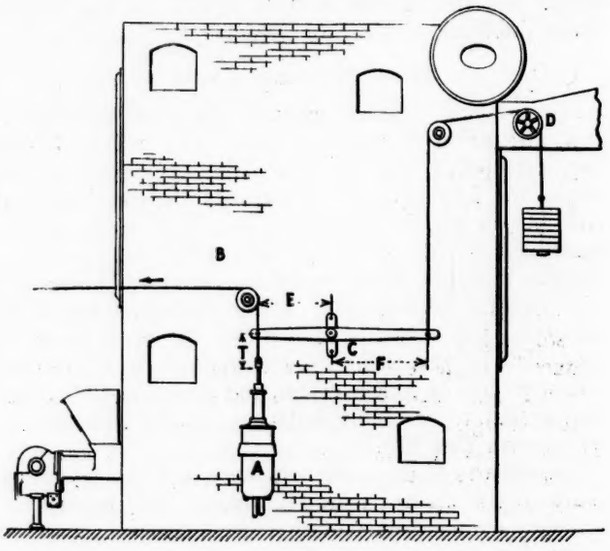
A Simple Combustion Control for Stoker-Fired Furnaces

THE illustration shows a simple combustion control, which we worked out a year or two ago and which has proved entirely satisfactory for controlling the over-fire draft on underfeed stoker-fired furnaces. In order to have a constant check on the operation of the control, a one-inch differential draft gage is mounted on the boiler front in a convenient position and connected to the furnace in the usual manner.

A is a steam-operated compensating damper regulator. Any good regulator will work satisfactorily as long as it is of the compensating type (the kind which will come to rest at a position other than wide open or tight shut). The cable *B* is connected through idler sheaves to the fan-engine control valve, which in this case is a chronometer lever-operated valve. Compensating lever *C* connects through cable and necessary idler sheaves with the sheave *D* on the stack damper shaft. This sheave or chain wheel is 18 in. in diameter, and is the type used on chain-operated valve wheels where valves are out of reach. A piece of chain is provided over the wheel *D* so that adjustment can be made by raising the chain off the sprocket and shifting it a link or two at a time until the desired over-fire draft is obtained. This draft, once adjusted, will remain within 0.02 in. at all positions of the damper because with a sprocket the travel is uniform instead of variable, as with the conventional type of lever.

The ratio of distance *E* to *F* on the lever *C* must equal the ratio of the distance *T* to one-fourth the circumference of the sheave *D*, because sheave *D* must make a quarter-turn while the piston on regulator *A* travels the distance *T*. Likewise, the lever on the fan-engine control valve must be of the correct length, so that the point at which the cable *B* connects will travel a distance equal to *T* on the regulator.

This installation was originally made on a furnace fired with underfeed stokers, on which an over-fire draft of 0.05 in. to 0.07 in. and an average of 12 per cent CO_2 was maintained. Unlike some combustion-control systems, which are more elaborate, this home-made outfit requires no adjustments other than the initial adjustment at time of installation. Should the draft in the furnace vary, a look at the fire will reveal a hole in the fuel bed or that the fire has become too thin for the load being carried on the boiler.



Compensating regulator controls speed of fan engine and position of stack damper

Cable *B* can be connected to the individual boiler blast gate or to the individual control valves on small turbine-driven blowers, in which case sheave *D* is also located on the individual boiler damper instead of the main stack damper.

Obviously, the investment for a control of this kind is small and a saving in the fuel, owing to the automatically controlled low over-fire draft, is well worth while.

R. J. NAGLE.

Westwood, N. J.

Reversing Panel Has Unusual Plugging Arrangement

A NEED recently arose for a reversing equipment for squirrel-cage motor, to meet several conditions of plugging, such as:

1. If the motor is running forward and the reverse button is pressed, the motor is to be plugged and started in the reverse direction.

2. If the motor is running reverse and the forward button is pressed, the motor is to be plugged and started in the forward direction.

3. If at any time the stop button is pressed, irrespective of the direction in which the motor is running, it is to be plugged and stopped.

The diagram shows how this was accomplished. Two reversing contactors, *F* and *R*, and two time-delay relays, P_1 and P_2, were used. The relays make a circuit instantly when energized and open this circuit after a time delay when de-energized. The operation of this equipment is as follows:

In case the forward push button is pressed, the forward contactor *F* and the time-delay relay P_1 close. If the stop button is pressed, the forward contactor opens and the circuit to the reverse contactor is made, closing this contactor. The reverse contactor will stay closed until either the stop button is released or time relay P_1 has timed open. The same operation is obtained if the reverse button is pressed as is obtained with the forward button, except that reverse contactor *R* is closed and time relay P_2 is energized. Then, if the stop button is pressed, the forward contactor closes and will stay closed until the stop button is released or the time relay P_2 has timed open. If the forward contactor is closed and the reverse button is pressed, the forward contactor opens and the reverse closes. Also, if the reverse contactor is closed and the forward button is pressed, the reverse contactor opens and the forward contactor closes.

If the forward button is pressed, it closes contacts 2-4 and a circuit is completed from the transformer through the stop button, the reverse button, the forward button, contact *D* on the reverse switch *R*, the coil on the forward switch *F* and back to the transformer. Completing this circuit energizes the coil on the forward switch *F* and this switch closes, starting the motor in the forward direction. When this switch closes auxiliary contact *A* opens, and *B*, and *C* close. Opening of *A* contact breaks the circuit through the reverse-contactor coil, and this switch cannot close as long as the forward switch is closed.

Closing contact *B* provides a holding circuit for the forward contactor from the transformer through the stop and reverse buttons, contact *B* and coil *F* back to the transformer. This allows the forward button to be released, and the forward contactor to remain closed. Auxiliary contact *C*, when closed, completes a circuit for timing relay coil P_1, from the transformer through the coil, contact *C* and to the transformer. Making this circuit alive closes the timing relay P_1. This completes the operations of the controller for forward motion of the motor.

Pressing the stop button opens the circuit through the forward contactor's coil circuit, and this contactor opens and closes auxiliary contact *A*, and opens *B* and *C*. The stop button closes a circuit for the coil on the reverse contactor *R*, from the transformer through contacts 5 and 7 on the stop button, time relay contacts P_1, auxiliary contact *A*, the coil of the reverse contactor *R* and back to the transformer. Therefore, when the stop button is pressed, the forward contactor opens and the reverse contactor closes.

When auxiliary contact *C* opens, it breaks the circuit through coil *F*, timing relay P_1, and this relay starts to time open. If the stop button is held down, the timing relay will open its contact, after a predetermined period, and break the circuit through the coil of the reverse contactor and the motor will be disconnected. The timing period of the relay is made such that the contactor will open about the time the motor has been plugged to rest. The other combinations of circuits can be easily worked out on the basis of the foregoing description.

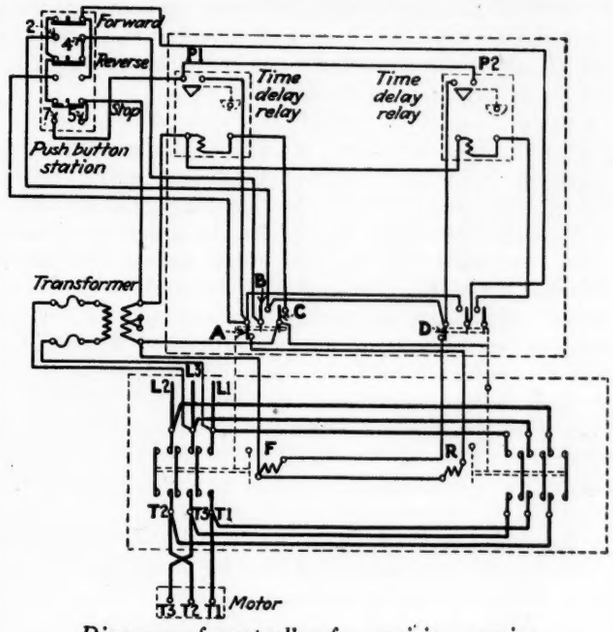


Diagram of controller for revising service

Schenectady, N. Y.

L. C. HARDESTY,
Industrial Control Engineering Dept.
General Electric Company.

Zeolite Softeners and Deconcentrators

THE article written by Messrs. Lucius A. Fritze and Elwood W. Scarritt, subject "Zeolite Softeners and Deconcentrators Give Improved Boiler Water," discusses the correction of the unfavorable ratio of sodium sulphate to sodium carbonate, which frequently follows the use of zeolite softeners from the standpoint of embrittlement, and therefore, discusses a subject of general interest. The subject of the article, together with the captions of the curves obtained from operating data, lead the reader to expect that the improvement in the ratio of sodium sulphate to sodium carbonate is accomplished by what seems rather erroneously termed a deconcentrator.

It is, therefore, a bit disappointing upon reading the article to learn that the deconcentrator has nothing to do with the sodium sulphate to sodium carbonate ratio. On the other hand, the only thing that increased the

ratio of sodium sulphate to sodium carbonate was feeding some raw water to the boiler to supplement the softened water from the zeolite softener. This raw water may either be introduced continuously into the boiler in mixture with the softener water or, as in the one test reported, raw water alone may be fed to the boiler for an interval of time after the boiler has been previously fed with softened water.

The deconcentractor referred to in this article has no effect upon any of the solids in solution, but is of value only to the extent that it removes suspended solids from the boiler water. It is noted that no curves nor data were submitted in the report to show the effect on the boiler water of removing some of the suspended solids.

Boiler skimmers sold under various names have been used for many years for removing the suspended solids from the boiler water. One of these methods depended to a considerable extent upon the radiation of heat as the water passed through the settling chamber to set up a flow through the boiler skimmer.

Another equipment, which was also termed a deconcentrator, depended upon a pump for withdrawing water from the boiler and filtering out the suspended solids. Wherever these boiler skimmers or deconcentrators have been used with value, dependence is commonly placed upon chemically treating the water within the boiler. Without doubt the introduction of chemicals to the boiler water, particularly if this is supplemented by testing the water in the boiler to insure a proper condition of the water, is very helpful from the standpoint of protecting the boilers from hard scale and corrosion. It is, however, very questionable whether the circulation of such a small amount of the boiler water through a settling chamber or deconcentrator as may be secured by thermal action is of any practical significance.

There is no doubt that many 1,500-sq.ft. return-tubular boilers are operated with more or less satisfaction by a mixture of zeolite-softened and raw water as boiler feed. With water of the character described by the authors, and with the same proportions of raw and softened water the sodium sulphate to sodium carbonate ratio would be the same that the authors reported even though the deconcentrator were not used.

There is also one statement in the article that should be corrected, particularly as its correction so well illustrates that lowering of the alkalinity of the boiler water has no relationship whatever to the use of the deconcentrator. The statement that requires correction is the following:

"It is to be noticed further that, during the period the combination system was in use, the low alkalinity would have permitted the maintenance of a proper sulphate alkalinity ratio, with the addition of but a small amount of sulphate, if the raw water had contained no sulphate salts."

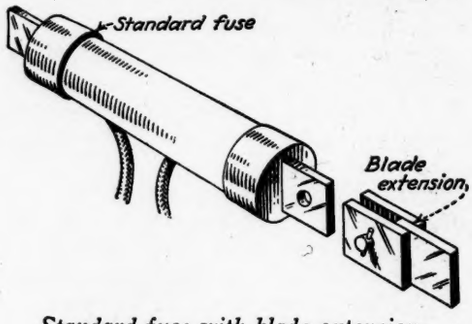
It is true that with the low alkalinity shown by Fig. 4, resulting from the feeding of raw water containing calcium sulphate to the boilers, not much sodium sulphate would have had to be fed to give a satisfactory relationship of sodium sulphate to sodium carbonate; but the authors overlooked advising that, if the raw water had not contained any calcium sulphate, the feeding of raw water in mixture with the zeolite-softened water would not have decreased the alkalinity regardless of whether or not a deconcentrator were used.

The only cause for the reduction of the alkalinity of the boiler water, aside from blowing down the boilers, was the feeding of calcium or magnesium sulphates contained in the raw water, which used up some of the alkalinity and formed sodium sulphate. If the raw water had not contained calcium and magnesium sulphates, this result could not have been obtained.

Philadelphia, Pa. J. D. YODER,
Cochrane Corporation.

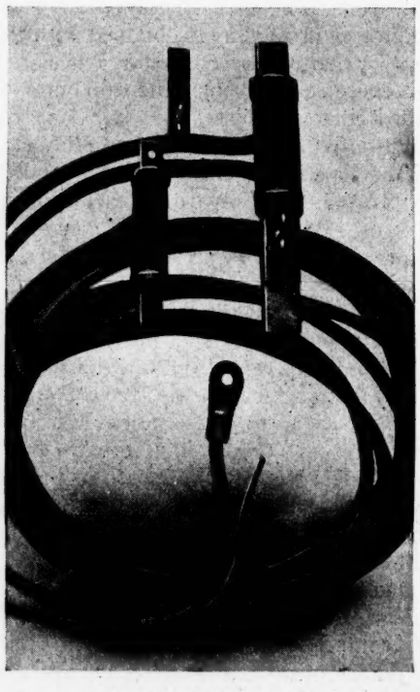
Dummy Fuse With Extension Blade Facilitates Testing in Industrial Plants

ALTHOUGH the use of dummy fuses and cables for testing the power consumption on 220-, 440-, and 550-volt circuits, by using different size fuses, is probably well known, the method of using one fuse for different capacity circuits will, I think, be new to many.



Standard fuse with blade extension

Instead of separate fuses for each voltage range a 250-volt fuse is used. When testing is to be done on 440-volt or 550-volt circuits, a simple blade extension is slipped over one of the blades and fastened in place with a thumbscrew which passes through a hole drilled in the blade.



Two sizes of fuses with blade extension handle practically all circuits

In this way the stock of "dummy fuses" and cables is about one-half what was formerly necessary without the blade extension. W. L. STEVENS.

Westminster, B. C., Canada.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Self-Contained Underfeed Stoker for Small Boilers

THE "King Coal," model B stoker illustrated is designed for use with boilers in sizes up to and including 1,000 sq.ft. of heating surface. The stoker, which operates on the underfeed principle, is a self-contained unit complete with motor drive, forced-draft fan, fuel hopper and feeding mechanism.

All principal parts of the stoker are of cast iron except the crank and connecting rods, which are of cast steel. The whole mechanism is driven by a 2-hp., 1,750 r.p.m. motor mounted on the top of the gear- and air-chamber housing. The initial drive to the fan and stoker is through a silent chain and the speed reduction for the stoker from the fan shaft is made by means of a single worm gear. The fan is mounted integral with the stoker, which eliminates the use of separate air ducts and makes a compact unit.

Coal is carried from a hopper at the side by a short screw conveyor and is pushed onto the grate by a reciprocating ram operated by connecting rods having a variable stroke from the crankshaft. The hopper can be located to suit the type of boiler or other conditions in the plant.

The grates are similar in design to those used on the model A stoker. They are hump shaped, made in small, easily replaceable sections. As will be apparent from Fig. 3, the tuyeres present only a small surface to the fire, while the air is conducted along flanges or ribs, which serve to cool the tuyere as well as to distribute the air evenly over the grate surface. The central feeding grate *A* reciprocates as does the feeding ram, but the stroke can be varied independently of the ram. The aërated, or active, grate surface *B* is augmented by side plates *C* which protect the sides of the firebox and give additional coal-burning surface.

The stoker is equipped with a pressurestat to control automatically the coal and air supply in relation to the steam demands on the boiler. The coal and air can also be varied independently by manual regulation. In Fig. 2 the levers *E* and *F* are shown, by means of which the coal feed and air supply are regulated.

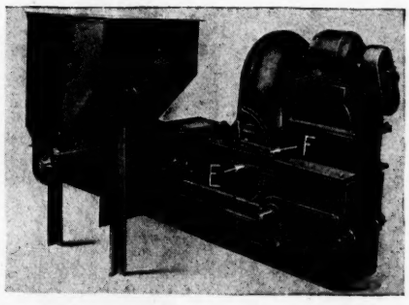


Fig. 2—View of stoker from hopper side, showing lever control for coal feed and air supply

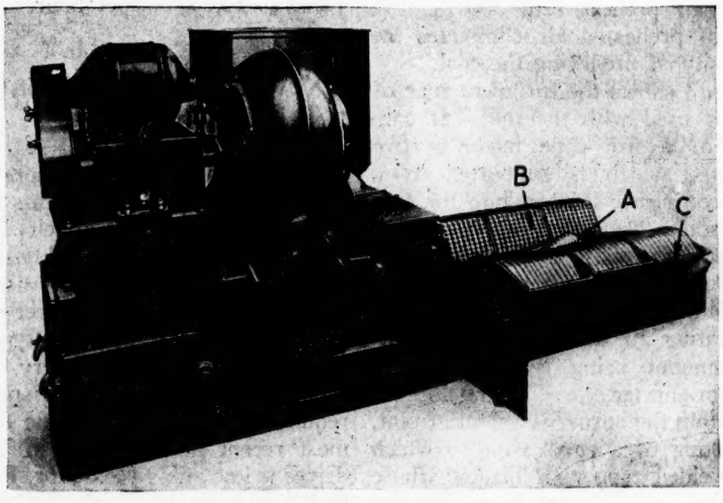


Fig. 1—Side view of model B stoker

Fig. 3—Tuyères have small fire surface but large cooling area

The stoker is manufactured by the Harrington Stoker Division of the Whiting Corporation, Harvey, Ill.

Unipulvo Underfeed Pulverizer

THE "Unipulvo" underfeed type of unit pulverizer recently developed by the Strong-Scott Manufacturing Company, of Minneapolis, Minn., offers several new features. The feeder is a reciprocating shoe *A* 24 to 30 in. long, extending the full width of the grinding chamber. The entire bottom of the coal hopper moves and the opening into the mill is six to eight inches high to take care of any oversize lumps up to six-inch cubes and to feed the coal regardless of its character and condition.

Feeding of the coal is regulated by varying the length of the stroke. Interconnected with the feeder is a set of oscillating "feeler" bars *B* (Fig. 2) in the grinding chamber. These bars lift on the forward stroke of the shoe and depress on the rearward stroke. When the feeler bars strike coal in their downward movement, the stroke of the shoe is shortened proportionally, providing in this way an automatic coal-feed regulation that maintains a constant level of coal in the mill. Means are provided for regulating the position of the stroke of the feeler bars to obtain any de-

sired depth of the coal bed. The feeder, being only about 20 in. above the base of the mill, admits of a coal hopper close to the operating floor, which can be supplied by shoveling if it is desired to eliminate coal-handling equipment in the smaller plants.

With the mill fan *C* (Fig. 1) mounted on the same shaft as the beater rotor and driven by the same motor, the Unipulvo is a complete self-contained unit, requiring no auxiliary equipment to supply the air for combustion. All the air required for combustion is taken through the mill and is used as a grinding agency. The aim of this design is to effect pulverization without the hammers striking or dragging through the coal. The hammers move the air and the air moves the coal. The grinding is a sand-blast action produced by the impingement of air-swept particles upon the dormant coal in the mill. The wear on the hammers is that due to the slip-off of the dust-laden air, so that ordinary bar steel may be used for hammers. The deep bed of material under the rotor serves as a catch-all for tramp metal, rock and other foreign material in the coal, which can be removed from time to time as it accumulates.

A feature of the mill tending to increase the grinding efficiency is the constant removal of the finished product every time the material goes

Fig. 1—Unipulvo underfeed pulverizer

around the rotor. The entire discharge of the rotor is drawn up into the separating chamber, from which the fines leave with the air and from which the oversize is returned for a second journey around the rotor. In the separator the vortex action is produced from the inside of the induced vortex and not from the outside, as is the common practice with centrifugal dust collectors. This prevents recapture of the oversize particles, which are permitted to spin out of the air stream to the outside wall, so that they may drop back. Provisions are made for regulating the intensity of the vortex action so that close regulation of the fineness can be maintained.

By taking all the air required for combustion through the mill and preheating the air in the furnace walls, it is possible to operate with wet coal. Reports are available showing successful operation at full rated capacity with lignite containing 38 per cent moisture, and with bituminous coal taken out of water storage, when

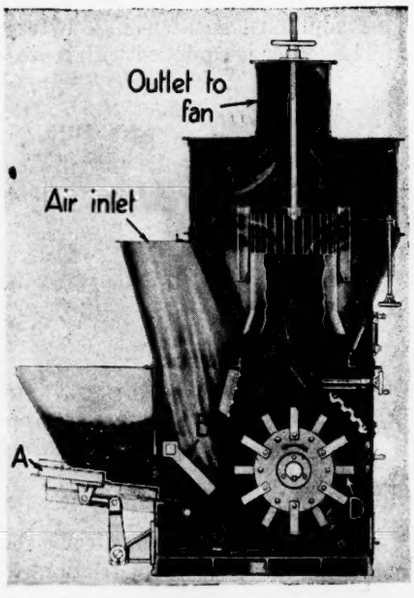


Fig. 2—Section through mill showing principle of operation

using air preheated to 300 deg. F. Use of preheated air eliminates the necessity of predrying the coal.

Fig. 3 shows the turbulent type of burner used with the mill. It consists of a fire cone made in two sections, which is supported by a cast-iron sleeve bricked into the furnace wall. Depending upon the size, the burner is six to ten inches smaller in diameter than the sleeve, leaving an annular opening for admission of ventilating air around the fire cone, the amount being controlled by a circular shutter.

Within the burner is a whirler unit, consisting of a small cone to which are welded tangential blades, whose function is to change lineal velocity to vortex action as the fuel-air mixture leaves the burner. It will be recalled that all the air for combustion passes through the mill, so that the full-air stream comes ready mixed to the burner, thus obviating the need for admission of secondary air at this point and relieving the burner of one

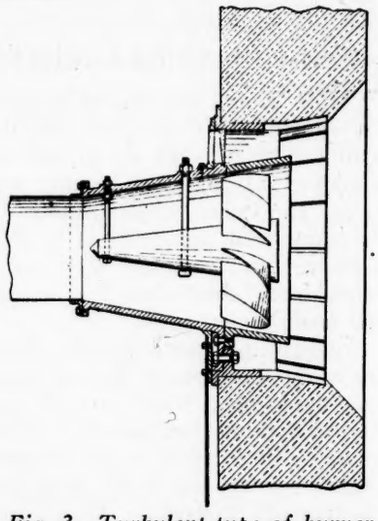


Fig. 3—Turbulent type of burner

of its usual functions. Adjustment of the blades makes possible practically any desired flame pattern or intensity of vortex.

Owing to the fact that the pulverizer is a self-contained unit, it is possible to mount it on a truck, so that it can be moved from boiler to boiler. The company reports several such installations, with the smaller units. This practice eliminates idle firing equipment when the boiler is down for cleaning and repair. In plants where two boilers are available and only one used, or where three boilers are available and only two used, the cost of one machine can be saved. The pulverizer is made in sizes that range in capacity from 1,000 to 10,000 lb. per hour.

New Multiple V-Shaped Belt Drive

IN THE last few years there have been extensive developments in the use of multiple V-shaped belts. Such drives are applicable to almost any type of service, and their use has solved many difficult power-transmission problems. This type of drive will operate on very short centers so that small floor space is required for the drive. One of the most recent developments in V-belt drives is known as Flex-Mor, Figs. 1 and 2, put out by Fairbanks, Morse & Company, Chicago, Ill.

The belting used with this drive is built with an outer jacket of duck treated with rubber to improve its wearing qualities. As shown in Fig. 1 this jacket consists of two layers of duck inclosing a core made up of a layer of rubber, several layers of rubber-embedded cords, and an-

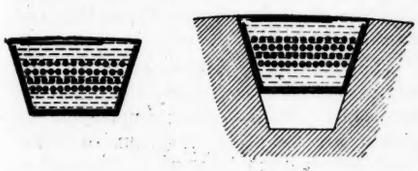


Fig. 1—On the left, cross-section of V-belt; on the right V-belt in a sheave groove

other layer of rubber above the cords. The layer of rubber below the cords is compounded to stand repeated compression, while the layer of rubber above the cords is compounded to stand repeated tension. The rubber-embedded cords are laid at the neutral axis of the belt, where there is the least tension or compression. These cords are made of long staple cotton, and the construction is quite similar to that used in cord tires. The various elements of the belt are assembled in a mold and vulcanized together into a unified structure.

The sheaves are made of semi-steel and have been designed with particular reference to the angle and depth of the grooves, so that the belt slippage is a minimum. The relation

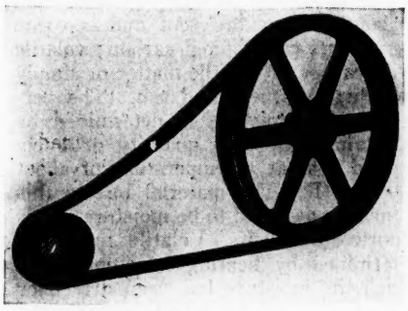


Fig. 2—Typical V-shaped belt drive

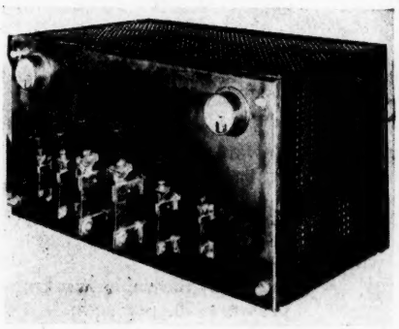
between the angle of the belt sides and the groove are such that the former makes a gradual contact with the latter as it bends around the sheaves. Owing to the wedging action of the belts in the grooves and to their elastic qualities, there is no grabbing of the load and sudden shocks to the driving and driven machines are eliminated. Belts are available in a wide range of lengths and capacities.

Cast Grid Rheostat

A CAST grid rheostat especially designed to withstand plating fumes and acids, has been put out by the Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland, Ohio.

The rheostat, which is of the parallel resistance type, affords regulation of both voltage and current, according to the generator voltage and character of plating. The operating panel is of heavy asbestos board, and the knife switches are all of substantial size to withstand more than the normal amount of current.

It is claimed that this type of resistor reduces heating to a minimum and eliminates high resistance joints, breakage and loose connections at point of contact.



Parallel-resistance type rheostat

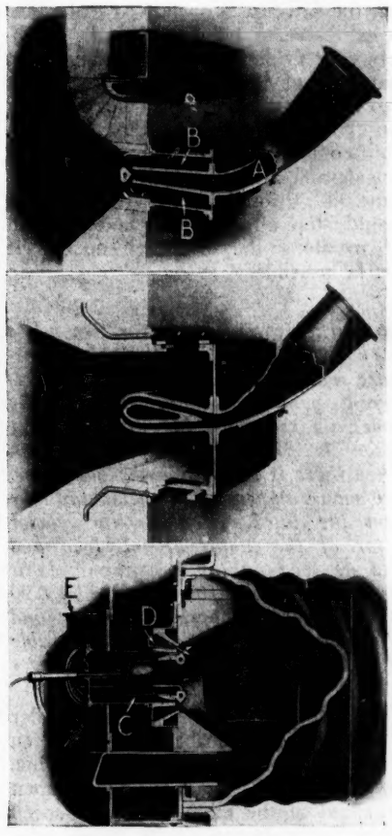
Types of Burners for Pulverized Coal

THE accompanying illustration shows three types of pulverized-coal burners used by the Kennedy-Van Saun Manufacturing & Engineering Corporation, 2 Park Avenue, New York City, for different types of furnaces.

In the vortex burner, shown in the top view, primary air and coal enter through the flat orifice *A* and impinge on a V-shaped deflector directly in front of the orifice. By impinging on this deflector the stream is divided, one part going upward and one downward. As the streams leave the deflector they are met by the secondary air supplied under pressure from the chamber *B*. This intermixing of the streams tends to give an intense turbulence at the burner tip and consequently a short flame.

The burner shown in the center view is intended for use where the secondary air is supplied by natural draft, shutters being provided on the top and bottom of the burner housing for the regulation of the air supply.

In the rotary burner which is suitable for coal, gas or oil, shown in the lower view, the primary air and coal enter at *E* and are delivered tangentially to the chamber *C*, then through an annular orifice and over a vortex tip, with a rotary action and at a relatively high velocity. The secondary air enters at *D* and is also given a rotary motion. This air enters the furnace on the outside of the



Pulverized-coal burners for use with forced draft, natural draft, or a combination of coal, gas or oil

coal stream and tends to cross it, as indicated by the arrows. This rotary burner is particularly adapted for use with Scotch marine and return-tubular boilers. Each of the burners is made in a variety of sizes suitable for either large or small installation.

Where three or more of these burners are supplied from one mill or a common pipe, a distributor consisting of a conical chamber containing a rotating cone is used. The distributor is designed to receive all the coal and air mixture as it comes from the primary fan and deliver it proportionately to each of the burner pipes connected to the opposite end of the distributor housing.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

EXPLOSIONS IN BOILER SETTING.—*We occasionally have an explosion in the passes of our water-tube boilers, one of which was so violent that the setting was damaged. The fuel is shavings and sawdust. What is the cause?* R.B.B.

Your letterhead indicates that the factory makes furniture. In many such plants, when sanding is used for finishing, the sawdust is so fine as to become as explosive as pulverized coal. Probably your firing varies to such an extent that part of the wood dust goes over into the passes, and when heavy firing causes a long flame, this dust explodes. This could not occur unless there was considerable air present; usually this air come in through the setting. You should stop all air leaks and feed all air in along the discharge nozzles if this be possible.

LOAD ON MOTOR-GENERATOR SET.—*We have a 200-hp. 2,200-volt three-phase induction motor driving a direct-current generator. According to the nameplate the full-load current of the motor is 47 amperes per terminal. When there is no load on the generator, how many amperes will the motor take from the line? What is the power factor of the motor at full load and with no load on the generator? Is it possible to have a power factor of 0.90 on one line, 0.85 on another line and 0.95 on another? Would it be possible for an induction motor to have a power factor of 0.12?* J.V.M.

When the motor is operating under no load, it will probably take about ten or twelve amperes from the line. This, however, depends to a large degree upon the speed of the motor. A high-speed motor has a better power factor than one that operates at low speed. The full-load and the no-load power factors will depend upon the design of the motor. For a high-speed machine, the power factor at full load may be above 90 per cent. On a slow-speed motor the full-load power factor may be less than 80 per cent. Under the no-load conditions in the problem the power factors of a high-speed motor may be around 50 and of a slow-speed motor about 20 per cent.

It is not only possible but very probable that the power factors of the various circuits making up a power system are different. It would be an accident if any two circuits had the same power factor. In fact, one circuit might have a lagging power factor and another a leading power factor, or any conceivable combination might exist.

A very slow-speed, poorly designed motor at no load might have a power factor of 0.12, but this is lower than is found for the average induction motor.

There is no rule that will answer the foregoing questions definitely, as there are many variables that affect the problems. Meters should be provided to determine the current and the power factor of the motor. Unless this is done, operation must be more or less a matter of guesswork.

MAXIMUM ALLOWABLE WORKING PRESSURE FOR CYLINDRICAL BOILER SHELL.—*With a factor of safety of 6, what would be the highest allowable working pressure for a cylindrical boiler shell 72 in. in diameter, made of ½-in. steel plate of 55,000-lb. tensile strength and 85 per cent efficiency of longitudinal joint?* E.E.

The formula for determining the maximum allowable working pressure for a cylindrical shell is

$$P = \frac{TS \times t \times E}{R \times FS}$$

in which

P = Maximum allowable working pressure, lb. per sq.in.
TS = Tensile strength of shell plates, lb. per sq.in. cross-sectional area.
t = Minimum thickness of shell plates, in inches.
E = Efficiency of longitudinal joint.
R = Radius = one-half the inside diameter of the outside course of the shell, in inches.
FS = The lowest factor of safety allowed.

Substituting the given values, the formula gives

$$P = \frac{55{,}000 \times 0.5 \times 0.85}{36 \times 6}$$

$$= 108.2 \text{ lb. per sq.in.}$$

maximum allowable working pressure.

REMOVING OIL FROM EXHAUST STEAM.—*In our plant we are using two Corliss engines operating condensing and at the same time are using live steam in our process hot-water vats. It has been suggested that exhaust steam could be used for the purpose, but the cylinder oil would damage the goods. Can this oil be removed?* A.C.L.

There are oil separators on the market that will remove practically all of the oil but if a total absence is desired, a heat exchanger should be installed. This is essentially a closed feed-water heater, and the exhaust steam heats the water flowing through the tubes.

BRAKE M. E. P. OF DIESEL.—*Frequently, I see in discussions of oil engines a reference to the brake mean effective pressure. Just what is this and how is it found?* G.M.

The maximum pressure in an oil-engine cylinder is usually over 500 lb. per sq.in. It is almost impossible to obtain an indicator diagram of sufficient accuracy to be used in computing the indicated mean effective pressure, for a heavy spring must be used and the pressure changes distort the diagram.

In oil-engine circles it is usual to rate the engine at a load such that the best fuel consumption per brake horsepower is obtained. The engineer then inserts this horsepower rating in the formula $\frac{PLAN}{33{,}000} = \text{H.P.}$, and solves for P, which he calls the brake m.e.p. Oil engines of any particular type have almost identical mechanical efficiencies, so, knowing the brake m.e.p., it is possible to judge very closely the mean effective pressure actually developed in the cylinder at the rated load. Mean effective pressures are used in oil-engine circles mainly to determine if the builder has exceeded a value that experience has indicated is the best for the particular type of engine the builder is offering for sale.

PROXIMATE AND ULTIMATE ANALYSIS OF COAL.—*What is the difference between proximate analysis and ultimate analysis of coal?* W.N.S.

The proximate analysis assumes coal to contain four different and separate ingredients called fixed carbon; volatile hydrocarbon or volatile matter or simply volatile; moisture; and ash. The percentage of moisture is determined by maintaining a small quantity of finely ground coal at a temperature of about 200 deg. F. The material lost in this manner is assumed to be moisture and is reported as such. Volatile matter is determined by heating a sample from which the moisture has been driven or a fresh sample, for which purpose the coal is held at a red to white heat, with exclusion of air until there is no further loss of weight. Fixed carbon is found by combustion of a sample from which the moisture and volatile have been driven off; and ash is the designation of the incombustible material left after determining the fixed carbon. The sum of the volatile, hydrocarbons, and fixed carbon is called the combustible. When sulphur is to be reported it must be determined by a separate analysis. The ultimate analysis is a thorough chemical analysis for determination of the percentages of carbon, hydrogen, oxygen, nitrogen and sulphur, and the percentage of ash in dry coal.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

DOES the meter showing air flow to the furnace and the steam flow eliminate the CO_2 instrument as a necessary boiler-room adjunct?

L. M. D.

A GREAT deal depends on just how efficiently combustion is to be maintained. With the steam-flow air-flow meter it is necessary that the relation of flow for each gas be arrived at by a series of tests to obtain complete combustion or as near complete combustion as is attainable with the rating developed. Therefore it is necessary to use an Orsat for determining the products of combustion, at which time the steam-flow air-flow pens on the recorder can be set to attain these test conditions in every-day operation as long as the coal being used has a similar proximate analysis and characteristics.

In the event of coal contracts being small, with the danger that the coal may have a different analysis, which would change the air requirements for each grade, it would seem advisable to have a CO_2 indicator or recorder. Any change in conditions of combustion could be immediately detected and remedied without a loss from incomplete combustion continuing during the burning of a carload or more of coal which has been found to vary to a considerable extent even though the coal may come from the same mine. E. H. CASSON.

Winnipeg, Canada.

ADEQUATE means of continuously, conveniently and accurately measuring the CO_2 content of the flue gas enable the fireman to tell whether he is firing his furnace in a proper manner to maintain maximum fuel economy.

No one can tell by looking at the chimney outlet how much heat is passing through it; nor is it always possible, by having the steam-flow and air-flow pens together, to obtain efficient combustion at all times.

A leaky baffle will not show up on the air-flow steam-flow record, and usually when this occurs the CO_2 reading will be affected immediately.

The meter can be adjusted to maintain the proper amount of excess air needed for good efficiency, but sometimes it requires slight changes, according to the grade of coal that is being fired. These adjustments can be made more quickly by the use of a CO_2 meter, than by a portable Orsat.

The steam-flow air-flow meter in itself is a very necessary boiler-room instrument, but used in conjunction with a CO_2 meter it is a more valuable instrument.

There is no reason why it should not be possible to use the CO_2 meter in connection with the steam-flow air-flow meter and making it just as necessary an instrument in the boiler room as any other meter.

The CO_2 meter is a recorder of all the losses going out the stack at all times, while the steam-flow air-flow meter is a recorder of losses only so long as the furnace is performing satisfactorily. M. W. HORLEY.

Holtwood, Pa.

THE meter showing air flow to the furnace and steam flow does not eliminate the CO_2 instrument as a necessary boiler-room adjunct.

The air-flow indicator is set to correspond with the steam flow when the flue gas contains the proper percentage of CO_2, and any change, occurring in the boiler and furnace, from the conditions which existed at the time this setting was made, will affect the efficiency of the boiler and furnace, but will not be indicated by the meter.

Several factors may influence the reading of the air-flow indicator, such as an increase or decrease of resistance to the flow of gas through the boiler. The atmospheric pressure in the boiler room may vary. When the boiler is being warmed up preparatory to being cut in with other boilers there is no steam flow with which to compare the air flow. Periods when the steam pressure is below normal the steam-flow indicator will show a higher flow of steam than actually exists. If the rate of boiler feed is increased, the steam-flow indicator will drop, and if the fireman at this time increases the fuel to hold the flow constant, the furnace will not receive the proper amount of air, even though the air-flow indicator corresponded with the steam-flow indicator.

The CO_2 instrument and a flue-gas thermometer will indicate two of the three greatest controllable heat losses in a boiler furnace. The CO_2 instrument is really the backbone of the air-flow steam-flow method of boiler operation, and as such should not be eliminated from the boiler room.

IVAR S. KINDBERG.

Iron Mountain, Mich.

IF THE question refers to the CO_2 indicator or recorder and not to the Orsat, the answer is yes, for the following reasons:

The majority of boiler installations require varying "total air" with changes in rating. The meter showing air flow to the furnace and steam flow can be adjusted to maintain the desired total air at all ratings with the air and steam pens coincident. The operator then requires the one instruction of keeping the air and steam pens together at all times.

Total air is the medium to be measured, and that is exactly what the air-flow steam-flow meter shows. The CO_2 indicator or recorder does not and cannot show total air because CO_2 alone is not the whole story. Oxygen and CO must be known in addition to CO_2 before total air can be determined from analysis.

The CO_2 indicator or recorder does not show loss due to combustion of carbon to CO. The operator, in his endeavor to operate on as high a CO_2 as possible, in all probability will reach the incomplete combustion range. This, of course, is eliminated in the air-flow type of meter since the minimum air, with pens together, is predetermined, and an insufficient air supply is strikingly indicated on the chart by the air pen falling below the steam pen.

The Orsat apparatus, on the other hand, is as essential as the CO_2 indicator or recorder is superfluous, since the Orsat is the primary standard against which the air-flow steam-flow relation must be checked.

WILLIAM G. LAUFFER.

Brooklyn, N. Y.

A Question For Our Readers

HOW can one calculate the efficiency of a superheater. C.B.C.

Suitable answers from readers will be paid for and published in the May 14 issue.

Specific Heat Determined For Superheated Steam

Up to 1,800 Lb. and 840 Deg. F.

THE methods employed in conducting the experiments outlined here for the higher pressures were the same as those outlined for pressures from 120 to 450 lb. and recounted in the four previous reports issued by the author and several collaborators. As in the earlier tests, the steam was generated in a small coal-fired or electrically heated boiler in which it attained an initial superheat. It then passed continuously through a calorimeter, in which its temperature was raised to the desired point by means of a measurable electric current, into a condenser. Accurately weighing the condensate and comparing the quantity of steam passing through the calorimeter per hour with the quantity of heat supplied to raise its temperature, made possible the calculation of the specific heat at constant pressure, c_p, with the provision that the heat supplied to the calorimeter was completely absorbed by the steam, no part of it being dissipated to the calorimeter walls.

The heat losses that had occurred by radiation during the previous experiments, were later determined by shutting off the steam and observing the amount of current required to hold the temperature within the calorimeter constant. This temperature loss was a decided disadvantage in the former calculations, but was then regarded as being unavoidable. The improvements made in the present calorimeter have successfully overcome this trouble by maintaining the temperature of the walls identical with the inside temperature. This was accomplished, after much experimentation, by the application of electric heating elements at eight different points.

Several experiments were made with this apparatus, with steam at pressures below 450 lb., as a basis for comparison with the results that had been previously obtained. Although the observations were made in the same laboratory, the intervening period of twenty years naturally brought about a change in the personnel, so that the same men did not take the readings. Likewise, the apparatus had been greatly improved.

Because of the extreme importance of this responsible work, it was deemed advisable to repeat all the previously recorded observations with the improved apparatus. No serious discrepancies were found, and most of the slight differences occurred near the saturation point or at the higher temperatures, where errors by interpolation were not likely to appear.

In analyzing the following results, it may be safely stated that the law governing the relation between the specific heat and the pressure at any given temperature continued to hold true throughout the entire range of high steam pressures. The specific heat at constant pressure increases with the pressure at any given temperature, and at a given pressure the specific heat increases more rapidly as the saturation point is approached.

Prof. Oscar Knoblauch, of the Polytechnic Institute, Munich, Germany, has previously published four reports, prepared with various collaborators, of his researches on the specific heat of steam. Herein is published an abstract of the fifth report, issued jointly by Professor Knoblauch and W. Koch, and originally reported in *Zeitschrift des Vereines Deutscher Ingenieure*, Dec. 1, 1928.

Theoretical Basis of the Calculations

The specific heat at constant pressure, c_p, was determined by means of the flow method, whereby the steam from the boiler is heated to several degrees above the desired temperature as it passes through a calorimeter by a measurable electric current. The steam leaving the calorimeter is condensed and accurately weighed. In calculating let

Q = the theoretical quantity of heat, supplied to the calorimeter, as figured by the voltage and current consumption in kilogram calories.

t_1 and t_2 = the temperature of the steam entering and leaving the calorimeter, respectively.

Then the average specific heat of the steam between the temperatures t_1 and t_2 may be calculated from the following formula:

$$c_p = \frac{Q}{G\,(t_1 - t_2)}$$

Since Q = the product of the voltage e and the amperes i

$$Q = 0.860\,ei\ Kcal \text{ per hour}$$

When the superheat added within the calorimeter $(t_2 - t_1)$ is very small, it may safely be assumed to vary directly with the temperature, this calculated average specific heat at the average temperature will be equivalent to $\frac{t_1 + t_2}{2}$

But the value of c_p obtained in this manner requires a slight correction. This is true, because the formula assumes that no change in pressure occurs, as the steam passes through the calorimeter. In practice the steam pressure when the steam leaves the calorimeter at the temperature t_2 is slightly less than at the entering temperature t_1 because all steam flow is necessarily accompanied by a pressure drop.

This means that the temperature difference $(t_2 - t_1)$ must be increased by a small quantity Δt. This quantity may be calculated from the formula developed by H. N. Davis, president of Stevens Institute of Technology. The corrected formula may then be stated as

$$c_p = \frac{Q}{G[t_2 - t_1 + \Delta t]}$$

The Equipment Used During the Experiment

The steam boiler consisted of a vertical seamless rolled steel cylinder, 775 mm. in diameter and 1,750 mm. high, with a wall 70 mm. thick. The normal water capacity is about 0.6 cu.m. Heat is applied by means of sixteen electric heating elements that pass through the cylinder wall. A maximum electrical load of 19 kw. was applied, but the elements were connected electrically in such a manner as to allow a wide flexibility in operation. During a total of 250 days of operation, no appreciable trouble was experienced with the boiler.

The feed water was supplied by a high-pressure piston pump, which forced the water through an electric heater into the boiler. The steam from the boiler passed through a non-return valve into two electric superheaters from which it entered the calorimeter. Since the presence of even a small quantity of moisture in the steam would have a detrimental effect on the functioning of these preheaters a suitable orifice plate was installed in the vertical steam pipe, immediately ahead of the non-return valve, from which the moisture was con-

tinually drained through a slightly opened valve.

In designing the electric steam preheaters it was necessary to employ heating elements that would give up the maximum amount of heat to the steam without acquiring an excessive temperature. The common baths were not considered, because air baths will not hold a constant temperature and liquid baths are frequently subject to chemical changes that may alter their specific heat or heat conductivity. For this reason each steam preheater was equipped with a return helical winding of seamless steel tubing, 9 mm. diameter and 7 m. long. This tubing is contained within aluminum cylinder walls that are cast around it.

The surrounding electric heating coils are made of a chrome-nickel alloy and are insulated from the aluminum and an external protective cylinder wall by means of "Mikanit." The coils are held in close contact with the aluminum by means of steel bands tightly wound around the outer cylinder. In this manner an efficient heat transfer to the steam is assured as it sweeps past the surface of the aluminum, which is itself an excellent heat conductor. This construction made it possible to load the preheater coils up to 1.5 kw. without raising their temperature more than 50 deg. C. above the steam temperature. This was verified by a sensitive thermocouple, installed under one of the steel bands surrounding the outer cylinder. To prevent radiation losses, the preheaters were immersed in larger tin cylinders filled with diatomaceous silica. This construction proved to be so efficient, that it was similarly applied in making the calorimeter.

The steam entering the calorimeter passes through a helically wound coil made from tubing 9 mm. in diameter and 7 m. long to the outlet. Aluminum is cast around this coil to form a cylinder about which a chrome-nickel electric heating element is wound and securely banded. The current enters the bottom of the element. For reasons to be stated later, the calorimeter body is surrounded by two concentric superimposed cylinders, made of 3 mm. sheet aluminum, with an airtight cover to form two annular air spaces, 8 mm. in width.

Auxiliary Heater Used

To compensate for the heat that may be absorbed by the calorimeter metal, the aluminum cylinders are surrounded by an auxiliary electric-heating cylinder, over which three additional concentric and airtight aluminum cylinders are placed. The small radiation loss of aluminum makes it possible to displace the usual solid insulating materials with air, thereby insuring a very slight thermal lag.

The compensating electric heating cylinder contains eight parts, which makes it possible to secure the desired temperature in any part. The first six of these heating elements are made from chrome-nickel, insulated with "Mikanit" and enclosed in sheet steel, the outside of which is nickel-plated to minimize the radiation loss. Preliminary tests showed that both connecting flanges of the calorimeter conducted heat away from the interior up to a point within the inner heating element. For this reason the flanges were fitted with two special heating elements.

The temperature of the heating elements and the calorimeter surfaces were measured by thermocouples, located at fifteen different points. All were equipped with cold ends packed in ice, to obtain the most accurate temperature readings. The thermocouples at points in the top half of the calorimeter were so wired and equipped with selective switches, that they could be made to operate in opposition to one another, to measure the temperature differences in the various parts. When used for direct temperature readings a millivoltmeter was used; when temperature differences were required these were read on a sensitive galvanometer.

Heat Transfer Prevented Within Calorimeter

The described method of compensating for the heat losses within the calorimeter proved to be effective. It was of further importance to prevent a heat transfer between the measuring points of the temperatures t_1 and t_2 and the calorimeter itself. This heat transfer takes place because the entering temperature t_1 is lower than that within the calorimeter, whereas the outlet temperature t_2 is somewhat less. To prevent this exchange of heat three aluminum baffle plates were installed in a vertical and in a horizontal position.

The steam temperatures t_1 and t_2 were measured inside of 3.6 mm. nickel tubes that were welded inside of both the inlet and outlet connections. The temperature was read on inserted thermocouples during the first part of the experiment, and later by means of resistance thermometers. Nickel tubes were used, because of their low heat conductivity, to minimize conduction of heat in an axial direction from the measuring point to the outside of the calorimeter. To reduce the heat exchange by radiation between the nickel tube and the inner surface of the connecting steam pipe, the former was fitted with a protecting element made from sheet nickel. Actually, the temperature measuring element is contained within a steam-heated space, which gives full protection against radiation losses.

The thermocouples contained a silver and a "constantan" alloy element, each 0.5 mm. in diameter. The temperature was obtained first by connecting the thermocouples with a cold end packed in ice and reading the resulting deflection on a millivoltmeter; and the temperature differences were then measured by connecting a selected pair of thermocouples to counteract each other and applying the Lindeck-Rotheschen compensation method. With due consideration of the human element in reading the mercury thermometer as well as the graphic compensation in calibrating the thermocouple elements, it was found that temperature readings to within 0.02 deg. could be taken. An accuracy to within 0.2 deg. in taking direct temperature readings was considered to be ample.

In order to check the temperature readings t_1 and t_2 which had been taken during the early part of the experiments by means of thermocouples, these readings were again taken, with resistance thermometers made of platinum wire. The construction of these thermometers was not simple, since it was necessary to insert them inside of the thermometer, tubes, which were only 3.6 mm. in diameter. Very little space was therefore available to hold the insulated resistance wire. The platinum wire was wound over a notched strip of insulating board. The notches in this strip were so deep that the wire could not come in contact with the metal wall when the thermometer element was inserted in the tube. The total length of the strip was 8 cm. Because of the high temperatures the electrical connections were made with gold wire. The resistance of the element was measured by a modified Wheatstone bridge. Since the temperature differences to be measured ranged between 3 and 10 deg., an accuracy to within .001 deg. was deemed to be sufficiently close.

The steam pressure at the inlet was measured by a spring pressure gage. For pressures up to 1,800 lb. there were three gages available, which were continuously in service, with a pointer travel up to three-fourths across their scale. These gages were recalibrated several times, but failed to show any serious error. The pressure differences across the calorimeter were read on a mercury manometer, connected at the steam inlet and outlet.

Construction of Manometer

The manometer was constructed to prevent imperfection in the meniscus, due to direct contact with the steam. It consisted of two Klinger water-column gages through which the height of the mercury column was plainly visible. The two gages are connected by a return bend fitting across their tops. This connection is filled with toluol, through a screw-capped opening. The bottoms of the gages are connected through U tubes and stop valves to the inlet and outlet points of the calorimeter. The pressure differential between these points causes the mercury to rise to different heights. The pressure between the mercury columns was transmitted by the toluol in the top cross-connection.

When the same height of mercury is assumed for both columns before the beginning of the test, it is possible to compute the pressure differences from the mercury column readings, if due consideration is given to the different specific gravities of mercury, water and toluol and the corresponding ratios of the cross-sections of the tube. However, since the height of the two mercury columns did not correspond at the beginning of the observations, it was necessary to introduce a correction factor to compensate for the existing difference. The latter was determined,

immediately following the experiments, by closing a needle valve located just ahead of the condenser. This shut off the steam flow and allowed the pressure to equalize on both sides of the manometer. The observed height of the mercury columns is therefore the zero point. The differences in height were read by means of a kathetometer.

This measured pressure difference, Δp, was always very small. For this reason it became permissible to denote the observed pressure at the inlet of the calorimeter, as the average pressure and equal to $P - \frac{\Delta P}{2}$.

The steam was condensed in a condenser and the condensate was accurately weighed.

Method of Testing and Results

The steam pressure was brought to the desired point in the boiler by adjusting the electric heating equipment. Owing to lack of previous experience in the application of electric heating elements to high-pressure boilers, the former were purposely chosen of ample capacity. Consequently, they were only lightly loaded and considerable time was required to raise the desired pressure. It was, therefore, necessary to start the boiler a day in advance of the experiments. The electric-motor-driven feed pump was started as soon as the steam was turned on to the calorimeter. This was necessary, because this pump returned the condensate to the boiler. Pressure variations in the boiler were corrected by adjustment of the heating elements or in the rate of feed-water input. No difficulty was experienced in maintaining a constant steam pressure during the experiments.

The steam flow from the boiler was regulated by the setting of a stop valve, located ahead of the condenser. The steam preheaters were adjusted to obtain the required superheat when the steam entered the calorimeter. The steam temperature was regulated by operating the primary preheater at full load, and making all heating adjustments on the second preheater. Current for heating the steam was supplied by a storage battery, which was a part of the laboratory equipment, when the heating load was light. At other times it was taken through a voltage regulator from the central-station service.

Current for heating the calorimeter was invariably taken from the laboratory storage battery. This facilitated the heat regulation to suit the immediate requirement. Considerable difficulty was experienced, and much time was lost in adjusting the heating elements that were intended to keep the outside of the calorimeter at the same temperature as the steam within, in order to eliminate the possibility of radiation losses. Under the most favorable conditions, this procedure occupied fully two hours, and often from two to three times this time

Results of Experiments

Experiment No.	Date	Pressure in Atmospheres	$\frac{t_1+t_2}{2}$ °C	t_2-t_1 °C	Δt °C	G kg/h	Q kcal/h	Period of Constant Conditions Maintained in Minutes	c_p kcal/kg°C	Thermometer Used
1	5. 10. 27	19.8	332.9	5.94	0.018	6.308	20.45	160	0.544	Thermo-couple
2	6. 6. 28	19.9	334.8	11.81	0.088	15.751	101.1	120	0.540	W = Resistance
3	4. 10. 27	19.9	335.9	12.01	0.065	13.328	86.2	120	0.536	Thermo-couple
4	12. 6. 28	29.9	241.6	3.62	0.064	15.414	45.43	140	0.801	W = Resistance
5	10. 10. 27	29.9	246.6	10.94	0.066	13.580	115.1	120	0.769	Thermo-couple
6	12. 6. 28	29.9	259.3	10.44	0.056	15.309	114.0	70	0.709	W = Resistance
7	11. 10. 27	29.8	283.8	10.48	0.062	15.196	102.1	50	0.638	Thermo-couple
8	11. 10. 27	29.8	320.1	10.73	0.048	13.931	87.9	80	0.585	Thermo-couple
9	21. 6. 28	29.9	353.9	5.08	0.031	13.457	39.07	90	0.568	W = Resistance
10	21. 6. 28	29.9	358.4	14.23	0.029	13.311	108.1	70	0.569	W = Resistance
11	12. 10. 27	29.8	386.3	11.18	0.054	13.826	85.9	75	0.553	Thermo-couple
12	25. 6. 28	29.9	433.9	6.21	0.036	14.840	51.6	80	0.556	W = Resistance
13	25. 6. 28	29.9	437.0	12.40	0.035	14.814	102.9	70	0.559	W = Resistance
14	1. 8. 28	29.9	493.2	6.56	0.025	13.723	50.65	70	0 560	W = Resistance
15	31. 7. 28	40.1	252.8	3.03	0.043	14.093	40.10	80	0.927	W = Resistance
16	18. 6. 28	40.1	257.3	2.79	0.056	15.779	40.87	100	0.909	W = Resistance
17	4. 11. 27	40.1	263.8	7.46	0.042	14.594	91.4	70	0.835	Thermo-couple
18	5. 11. 27	40.1	274.0	9.32	0.027	12.395	90.3	100	0.779	Thermo-couple
19	5. 12. 27	40.1	288.5	9.16	0.046	14.400	94.6	120	0.714	Thermo-couple
20	5. 12. 27	40.1	322.7	9.87	0.044	14.983	94.1	90	0.633	Thermo-couple
21	26. 6. 28	40.1	371.2	10.42	0.038	14.513	90.4	60	0.595	W = Resistance
22	26. 6. 28	40.1	403.7	11.28	0.032	14.480	94.2	80	0.576	W = Resistance
23	26. 6. 28	40.1	436.5	11.34	0.031	14.936	97.1	100	0.571	W = Resistance
24	20. 6. 28	40.1	436.8	10.96	0.032	15.950	100.0	120	0.571	W = Resistance
25	2. 8. 28	40.1	494.0	8.18	0.019	13.729	64.1	60	0.569	W = Resistance
26	15. 6. 28	60.2	280.3	2.16	0.028	15.200	36.75	90	1.105	W = Resistance
27	15. 6. 28	60.2	283.8	7.46	0.026	14.724	114.7	60	1.040	W = Resistance
28	28. 11. 27	60.1	287.5	7.08	0.016	12.220	86.3	80	0.994	Thermo-couple
29	2. 11. 27	60.2	301.1	8.92	0.015	12.078	94.9	60	0.879	Thermo-couple
30	28. 11. 27	60.1	324.6	9.83	0.022	14.473	107.4	180	0.754	Thermo-couple
31	22. 11. 27	60.1	334.6	9.37	0.023	15.097	103.3	80	0.729	Thermo-couple
32	27. 6. 28	60.2	368.0	11.15	0.019	13.685	100.2	90	0.655	W = Resistance
33	22. 11. 27	60.1	369.2	10.15	0.015	13.375	87.2	25	0.641	Thermo-couple
34	13. 6. 28	60.2	429.0	10.13	0.016	16.280	100.0	80	0.605	W = Resistance
35	27. 6. 28	60.2	437.7	13.71	0.016	13.103	108.9	90	0.606	W = Resistance
36	11. 7. 28	80.0	297.6	3.12	0.018	14.477	61.6	80	1.355	W = Resistance
37	11. 7. 28	80.0	300.5	7.65	0.014	13.879	134.8	80	1.267	W = Resistance
38	25. 10. 27	79.9	309.7	8.27	0.028	17.723	165.2	45	1.123	Thermo-couple
39	22. 10. 27	79.9	326.2	12.99	0.009	10.533	126.8	40	0.927	Thermo-couple
40	10. 11. 27	79.9	341.5	9.47	0.017	14.924	117.2	100	0.828	Thermo-couple
41	3. 7. 28	80.0	375.0	5.47	0.011	13.046	51.5	80	0.721	W = Resistance
42	3. 7. 28	80.0	377.5	10.60	0.011	12.996	99.9	160	0.724	W = Resistance
43	5. 7. 28	80.0	421.0	5.95	0.013	14.278	55.6	70	0.653	W = Resistance
44	5. 7. 28	80.0	423.7	11.28	0.014	14.689	108.9	130	0.657	W = Resistance
45	17. 7. 28	100.2	314.9	5.18	0.009	12.675	100.4	70	1.527	W = Resistance
46	29. 11. 27	100.2	317.9	3.47	0.006	13.011	68.8	65	1.526	Thermo-couple
47	17. 7. 28	100.2	318.0	9.79	0.009	12.636	176.1	80	1.422	W = Resistance
48	29. 11. 27	100.2	324.5	9.61	0 005	12.543	163.2	60	1.354	Thermo-couple
49	1. 12. 27	100.2	335.0	10.26	0.010	13.370	154.8	90	1.128	Thermo-couple
50	6. 12. 27	100.2	352.5	10.80	0.012	12.270	125.2	60	0.944	Thermo-couple
51	6. 12. 27	100.2	376.1	10.79	0.010	12.563	111.2	120	0.819	Thermo-couple
52	19. 7. 28	100.2	411.9	9.85	0.011	14.379	102.7	70	0.724	W = Resistance
53	19. 7. 28	100.2	410.1	4.76	0.010	14.112	49.30	70	0.732	W = Resistance
54	24. 7. 28	120.1	326.9	3.75	0.008	13.638	100.9	90	1.967	W = Resistance
55	24. 7. 28	120.1	328.6	4.62	0.008	13.393	115.9	60	1.870	W = Resistance
56	27. 7. 28	120.1	335.4	7.93	0.008	12.574	154.7	70	1.550	W = Resistance
57	11. 11. 27	120.1	342.2	10.81	0.005	11.301	166.7	70	1.363	Thermo-couple
58	15. 11. 27	120.0	345.1	9.58	0.007	13.190	167.5	50	1.324	Thermo-couple
59	11. 11. 27	120.1	352.7	11.02	0.004	10.289	136.1	80	1.200	Thermo-couple
60	15. 11. 27	120.1	365.9	10.17	0.002	10.468	109.3	80	1.026	Thermo-couple
61	27. 11. 27	120.1	389.0	9.75	0.006	11.271	94.8	120	0.862	Thermo-couple
62	27. 7. 28	120.1	427.6	9.52	0.006	13.744	97.5	70	0.743	W = Resistance

was required to accomplish the desired purpose. The electric connections between two corresponding heating elements in the inner and outer calorimeter cylinders had to be connected in opposition and regulated to counterbalance each other, so that the resulting temperature reading was brought to zero.

To insure accuracy, special provision was made in the method of taking these measurements. For this reason the air space surrounding the outer cylinder carrying the compensating heating elements, was divided into two annular sections, by the three outer aluminum cylinders. As long as even slight differences in temperature between the calorimeter wall and the protecting or compensating heating cylinder exist, heat will flow from the former to the latter, the quantity depending upon the temperature difference between the two and the resistance offered by the intervening air spaces. This resistance is increased by the aluminum cylinders, which radiate only a very small amount of heat, and are an effective means of preventing the outflow of appreciable heat from the calorimeter to its surroundings.

Conversely, during possible fluctuations in the equalization of the temperature between outer and inner points, even a comparatively slight outflow of heat will result in a large difference in temperature. This fact enabled the observers to make very accurate adjustment of the heating elements.

The last difficulty to be overcome was to hold the temperatures t_1 and t_2 constant. This was done by regulating the compensating heating elements surrounding the calorimeter inlet and outlet connections, to bring the temperature differences between the points of determination to zero, which eliminated the radiation losses from the inlet and outlet tubes and made it possible to obtain the correct readings of the temperatures t_1 and t_2.

During the experiments with the heating elements the temperature t_1 and the temperature difference $(t_2 - t_1)$ were read every five and ten minutes, respectively, on the resistance thermometers. The condensate was received in a vessel and weighed every five or ten minutes.

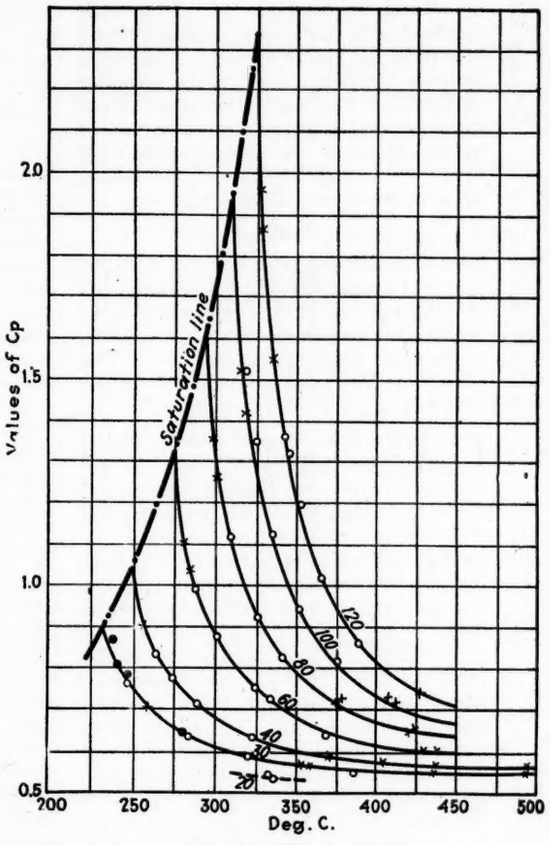
About twenty-five preliminary tests of the apparatus were necessary before the final sixty-eight tests could be made. From the latter six tests had to be discarded for various causes.

The steam flow generally ranged between 12 and 15 kg. per hour for pressures of 450, 600, 900, 1,200, 1,500 and 1,800 lb. The maximum temperature for 400 and 600 lb. was 930 deg. F. and averaged 800 deg. F. for the higher pressures. The temperature rise within the calorimeter ranged between 3½ and 25 degrees F. Near the saturation point the temperature of the steam entering the calorimeter was not permitted to fall below 3½ deg. above the saturation temperature, to avoid the entrance of moisture into the calorimeter. During this part of the experiment the degrees of superheat $(t_2 - t_1)$ were kept as low as possible, in order that the average temperature $\frac{t_1 + t_2}{2}$, which determined the value of c_p, would be in close proximity to the saturation temperature.

During every phase of the experiments, both with the higher pressures and at the higher temperatures, comparative tests were made with high and low degrees of superheat, to determine whether all radiation losses had been stopped. If this had not been true, the errors at low degrees of superheat would have been greater than with higher superheat and would have shown deviations in the values of c_p. These errors were avoided by the high efficiency of the apparatus.

The values of c_p resulting from sixty-two tests are given in the table and are graphically represented by the accompanying curves. The observations with thermocouples are designated by *o* and those with the resistance thermometers are marked + on the curves. No basic deviation between the two methods of temperature measurement are discernible.

By plotting these values with their corresponding pressures c_p isobars are obtained in the $c_p - t$ diagram.



Variations of Specific Heat with Temperature at Different Pressures

Corroborating the earlier tests with steam at pressures up to 450 lb., it was found that the specific heat c_p at a given temperature increases with the pressure, and that, at a given pressure, beginning at the saturation point, the specific heat c_p decreases with increasing temperature. This decrease has a tendency to become more marked as the pressure increases.

The earlier experiments with steam at the lower pressures had shown that a decrease in the specific heat near the saturation point was followed by an increase in the specific heat when the temperature was increased at the higher degrees of superheat. This characteristic progresses with increasing pressure at which it occurs at much higher temperatures. It can easily be noted at pressures up to 450 lb., and is still indicated by the constant c_p at temperatures between 825 and 930 deg. F., but cannot be detected at the higher pressures, within the temperature range afforded.

In order to reconcile the new c_p values for pressures above 450 lb. with those previously determined for pressures up to the latter, the values of c_p found by Knoblauch and Raisch are marked by concentric circles *o* in the curves. The diagram also shows the c_p isobar at 300 lb. as obtained by three tests at an average temperature of 635 deg. F. The latter results correspond very closely to those obtained from the earlier experiments.

A new set of steam tables based on these experiments for pressures up to 1,800 lb. is now in course of preparation. It is planned to extend these temporarily to the higher pressures by interpolating the experimental values. A new apparatus has already been designed to carry on the experiments with steam at pressures up to 3,750 lb., during which particular attention will be paid to the results obtained near the critical pressure, where it is assumed that the specific heat is equal to infinity.

THE MOST STRENUOUS BATTLE waged in recent years for a water-power site in Western Canada will be conducted shortly before the Provincial Water Power Board of British Columbia, when the Campbell River question is taken up. It has just been announced that the board will deal with this contentious matter before the end of April. Three concerns, it is stated, will have equal priority in applying for licenses, which will allow the harnessing of the stream and the damming of Buttles Lake in Stratconia Park. These three competitive power companies are the British Columbia Power Corporation, the Campbell River Power Company and the Crown Willamette Company.

RECENT PUBLICATION

THE ELEMENTS OF PRACTICAL MECHANICS. By Charles R. MacInnes, Professor of Mathematics, Princeton University. Published by D. Van Nostrand Company, 8 Warren St., New York City, 1929, Cloth; 6x9 in., 131 pages; numerous diagrams and exercises. Price $2.25 net.

THIS book is intended for use with classes of engineering students. While it assumes some knowledge of calculus, the mathematical treatment is relatively simple and is accompanied by graphical treatment. Problems with answers are given at the end of each chapter.

The following chapters are included: Co-Planar Concurrent Forces; Co-Planar Non-Concurrent Forces; Non-Co-Planar Forces; Center of Gravity and Centroids; Rectilinear Motion; Curvilinear Motion; Work, Energy and Power; Moment of Inertia of Area; Moment of Inertia of Mass; Motion of Rigid Bodies; Impact and Momentum; Examples Involving Friction. The book is compact and will be useful to engineers who desire to review the fundamental principles of mechanics without too much loss of time.

MATTHEW MURRAY, PIONEER ENGINEER. By E. Kilburn Scott. Published by the Matthew Murray Memorial Fund, Westminster Bank, Leeds, England, 1929. Paper, 5½x8½ in., 132 pages. Price 60 cents.

ALL who are interested in the origin and development of mechanical devices and methods will be glad to read not only of the achievements of Matthew Murray, to whom we evidently owe more than most of us realize, but of his struggles against powerful odds. Written for the hundredth anniversary of his death, it outlines the active part he played in developing many types of machinery. For seventeen years before Stephenson's "Rocket" won the Rainhill contest, Murray's locomotives are reported to have been running regularly between Hunslet and Middleton, a 5-ton locomotive hauling 90 tons. George Stephenson, it is reported, came to Leeds the next year, 1813, to see Murray's locomotives at work.

Murray seems to have been both fertile in ideas and versatile in his inventions. He was also unfortunate in having his ideas credited to others, his patents nullified and his ambitions thwarted. His parallel motion was erroneously credited to James White, some of his patents on steam engines were set aside in favor of Boulton and Watt, who, according to their own letters, were guilty of about all the unethical practices with which business men could be charged. Those who do not appreciate how modern business has advanced ethically, will do well to read the letters of Boulton and Watt as published in this volume. Nothing in this century will equal them for ruthlessness and trickery in dealing with a competitor. Two chronologies are given, the one from 1758 to 1875 being of particular interest.

Born in 1765 and dying in 1826, Matthew Murray left us much by which he should be remembered. His work included boilers, pumping engines, steam heat in houses, locomotives, boring mills, hydraulic-testing machines, the spinning of flax and the like. The sponsors of the book desire to erect suitable tablets to commemorate the achievements of a man who accomplished much but whose name is not known as it should be.

STANDARD WIRING FOR ELECTRIC LIGHT AND POWER. By H. C. Cushing, Jr. Published by H. C. Cushing, Jr., 15 W. 55th St., New York City, 1929. Flexible binding; 4½x6½ in.; 102 tables; 221 illustrations; 504 pages. Price, $3.

IN THIS book is told how to install wiring for light and power in accordance with the National Electrical Code. Explanations, illustrations and table are given that are necessary for outside and inside construction. This is the thirty-fifth annual edition and the text has been revised and brought up to date.

New sections have been added on the National "Red Seal Plan" for adequate house wiring and on the "Franklin Specification" for the lighting of commercial-, industrial- and public-building interiors and home lighting. Practically every class of wiring has been included, and the treatment is based on the National Board of Fire Underwriter rules. The work has been written for the practical man and is presented in language that he can understand. Those having to make electrical installations will find this little book of valuable assistance.

BEGRENZUNG DER LEISTUNGSSTEIGERUNG DER SCHNELLAUFENDEN VERBRENNUNGS-MASCHINE DURCH DEN STEUERVORGANG. (Limitations in increasing the capacity of high-speed internal-combustion engines by valve gear changes.) By Dr. Manfred Christian. Bulletin 315. Published in German by the V. D. I., Berlin. Paper; 8⅜x11⅝ in.; 19 pages; 20 illustrations; 4 tabulations.

THIS paper is a theoretical treatise, dealing with the influence of valve gear design on the speed and power output of internal-combustion engines. The work is highly analytical in its discussion, which is confined principally to automotive engines having piston displacements between 100 and 500 c.c. Disregarding the inertia effect of the combustible mixture, it is shown that the upper limit of speed increases as the cylinder diameter decreases. The acceleration imparted by cams of various contours and the resulting stresses in the valve gear are computed. The results indicate a maximum speed of 7,000 r.p.m. for cylinders 45 mm. in diameter, which decreases to 5,000 r.p.m. with a cylinder diameter of 80 mm. It is shown that positive driven valves that have been developed do not permit these speeds to be exceeded. The single- and double-sleeve valves show a theoretical gain in this direction, but are not suitable for very high speeds in practice, owing principally to the retarded heat transfer from the piston to the cylinder walls.

1. DER WAERMEUEBERGANG BEIM KONDENSIEREN VON HEISS UND SATTAMPF (Effect of Heat Transfer upon Condensation of Superheated and Saturated Steam). 2. DIE VERDAMPFUNGS MAERME DES WASSERS UND DAS SPECIFISCHE VOLUMEN VON SATTDAMPF FUER TEMPERATUREN BIS 210 DEG. C. (Latent Heat of Evaporation and the Specific Volume of Saturated Steam for Temperatures up to 210 Deg. C.). By Prof. M. Jacob and Dr. S. Evk. Bulletin 310. Published in German by the V.D.I. Berlin. Paper; 8½x11⅝ in.; 19 pages; 23 illustrations and 9 tabulations.

THE first of these papers describes the research and tests conducted with refined laboratory apparatus to compare the heat transfer by superheated and by saturated steam under identical conditions. The tests were made in a vertical externally cooled pipe, provided with thermo-electric couples for determining the wall temperature over the entire length. Although the authors had to work with steam at 15 lb. pressure, the results apparently confirmed the calculated better heat transfer with superheated steam as claimed by the Nuselt water film theory of condensation. The experiments will be continued with steam at higher pressures.

The second paper describes experiments that were made in an attempt to reconcile the discrepancies in the figures given by several leading authorities on the latent heat of evaporation and the specific volume of saturated steam. Extraordinary precautions were taken to insure accuracy. The results are compared with those previously obtained by Herminger, and a new table is calculated for steam temperatures between 30 and 210 deg. C. The formula by Clapeyron-Clausius is applied to compute the specific volume between the given temperatures, which are assumed correct to within 0.2 per cent by the author. The values given check very closely with those given by Knoblauch, Linde and Klebe. The tests will be continued with steam up to 250 deg. C.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING

INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Ruling Is Given On Authority to Fix Power Rates

Federal Commission Held to Have Jurisdiction in Interstate or Foreign Commerce

THE Federal Power Commission's jurisdiction over rates and services of public service corporations or agencies extends as far as they constitute interstate or foreign commerce and also extends to the securities of licensees of the Commission, subsidiary corporations whose stock is owned or controlled directly or indirectly by a licensee and to persons, associations, and corporations purchasing power from a licensee for distribution or use in public service.

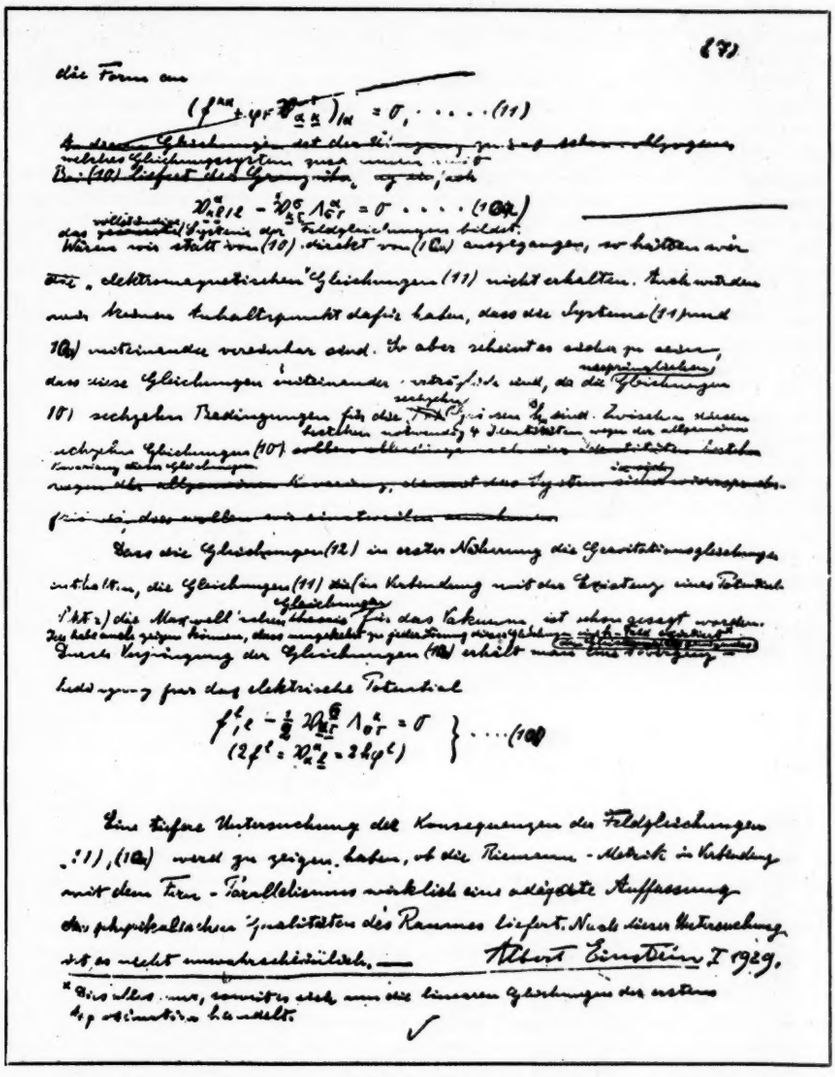
This, in substance, is the opinion of the chief counsel of the Federal Power Commission, Maj. L. W. Call, submitted to the executive secretary of the Commission, O. C. Merrill, in response to certain questions asked by the latter.

The opinion, which has been approved by the Commission and therefore becomes a ruling of the Commission, has just been made public by Mr. Merrill.

The ruling also holds that the Commission's jurisdiction over intrastate commerce in electric energy within any State may be exercised only to the extent, and as long as, the State has not provided its own agencies of regulation, and that it extends to licensees of the Commission and to their customers only in so far as they are engaged in the public service and only to the extent that the acceptance of such jurisdiction is a contractual obligation enforceable on the parties.

The ruling holds, further, that the statute imposes a duty upon the Commission to exercise its jurisdiction to regulate rates, services and securities whenever complaint is filed by any person aggrieved or when request is made by any State concerned and that, under such circumstances, it is not within the discretionary authority of the Commission to decline to exercise jurisdiction.

"In the case of rates charged or services rendered by a public service corporation, subject to the jurisdiction of the Commission," continued the opinion, "any person whose pecuniary interests are affected would be entitled to file complaint with the Commission; and, if such complaint make a prima facie showing to such effect, the Commission must take jurisdiction."



A PAGE from "Zur Einheitlichen Feld-Theorie," in which Prof. Albert Einstein recently gave to the world his newest theory. The original manuscript is in the possession of Wesleyan University, Middletown, Conn., where it will be permanently kept and cared for in the Olin Library.

Hell Gate Plant to Have Two New Boilers

Two new boiler units have been ordered from the Babcock & Wilcox Company for the Hell Gate generating station of the United Light & Power Company, of New York City. Installation will start as soon as delivery is made, and it is expected the boilers will be ready for service by August, 1930.

Each boiler unit consists of Twin Babcock & Wilcox boilers, superheaters, economizers and air heaters. The boilers, which will be as large as any ever built, will supply steam to drive one of the 160,000-kilowatt turbine-generators now being installed. Each will supply a maximum of 800,000 lb. of steam per hour at a temperature of 725 deg. at 275 lb. pressure.

The furnaces will be equipped with Bailey water walls throughout and will be of the slag tap design.

The boilers will be fired by pulverized coal, six burners for each boiler and each boiler will be equipped with four pulverizing mills. The consumption of coal will be at the rate of approximately forty tons an hour for each boiler when operating continuously at its maximum.

A.S.M.E. Rochester Meeting of Special Interest to Power Engineers

AT ITS MEETING, May 13 to 16, 1929, the first to be held in Rochester, N. Y., the American Society of Mechanical Engineers will present a splendid array of technical papers. Many of these are of special interest to power engineers.

On Monday morning, at the opening session, a symposium on boiler-furnace refractories will be given, consisting of the following papers: "A Laboratory Slagging Test for Boiler-Furnace Refractories" by R. K. Hursh; "A Study of Crystalline Compounds Formed in Slags" by T. A. Klinefelter and E. P. Rexford; "Some Factors in the Removal of Ash as Molten Slag from Powdered-Coal Furnaces" by Ralph A. Sherman, P. Nicholls and Edmund Taylor; "Evolution of Slag-Tap Furnace at the Chas. R. Huntley Station, Buffalo, N. Y." by H. M. Cushing; "The Present Status of Tests for Refractories" by S. M. Phelps and J. S. McDowell; "Proprietary Air-Cooled Refractory Walls" by C. S. Gladden.

At the afternoon session papers will be presented on: "The Calculation of Flywheels for Air Compressors" by H. R. Goss and H. V. Putnam; "Vibration Damping" by A. L. Kimball; "Formation and Heat Transfer Effects of Calcium Sulphate Boiler Scale" by E. P. Partridge and A. H. White; and "Control of Boiler Water Treatment to Prevent Embrittlement" by F. G. Straub.

The session on Tuesday offers, among other subjects, "Economies in Power Transmission" by W. W. Nichols; "Heat Insulation Practice in the Modern Steam Generating Plant" by L. B. McMillan, and "Surface Transmission" by R. H. Heilman.

"Design and Proportions of Economizers and Air Preheaters" will be presented by Hosea Webster on Wednesday morning, and on Thursday the following papers will be given: "The Concurrence and Elimination of Surge or Oscillating Pressures in the Discharge Lines of Reciprocating Pumps" by H. Diederichs and W. D. Pomeroy; and "Machine for Making Creep Tests at High Temperatures" by G. D. Bagley.

In addition to the technical meetings, an interesting program of sight-seeing and entertainment has been arranged. Ample time is allowed in the schedule for becoming familiar with the outstanding features of Rochester, where many engineers are noted for their attention to public affairs. A large attendance is expected.

Iron and Steel Electrical Engineers Hold General Ideas Meeting

At the Philadelphia Section Meeting of the Association of Iron and Steel Electrical Engineers, held in the Philadelphia Engineers Club, April 6, four short papers were presented. The first of these was by C. M. Thompson, plant engineer, Henry Disston & Sons, Inc. Mr. Thompson outlined the changes made in his plant after an old 250-hp. rolling-mill engine broke down. To repair and put the unit in shape again for operation was one of nine propositions considered.

The power factor of the system was low and there was also need for more power capacity. A broad engineering study was made of the plant's power problem, as a result of which the old steam engine was not repaired but was replaced by an adjustable-speed direct-current motor. The power facilities were extended to meet future demands and the power factor of the system corrected to about 97 per cent.

Of the nine propositions considered, the one involving the most extensive changes and the highest cost was adopted. This proposition also showed the largest saving. The reduction in operating costs and the increase in efficiency will pay for the change in a little over three years.

In the discussion on this paper the opinion was expressed that where adjustable-speed drives are required, there is a tendency toward the use of direct-current motors.

Martin J. Conway, fuel engineer, Lukens Steel Company, presented a paper on "Smoke Abatement in the Steel Industry." Mr. Conway said that smoke abatement was fast becoming an important subject in crowded districts. The large plants have done much to eliminate smoke, but the small ones were still serious offenders. The solution of the smoke problem depends upon the proper combustion of the volatile matter in the fuel, which the speaker explained can be accomplished in a properly designed furnace.

Mr. Conway pointed out that smoke abatement does not impose a penalty upon industry, but, may be beneficial by reducing the cost of fuel and by improvements in the product manufactured. The speaker summed up the smoke abatement problem by saying, "Industrial plants that emit clouds of black smoke are no longer an indication of industrial prosperity, but rather an indication of fuel waste and an indifference to the welfare of the community."

"Power Economy," was the subject of a paper by R. M. Fuller, consulting engineer. In the paper the author discussed a power and heating installation that he had made a study of. In 1927 the operating costs were $52,530. By spending $25,881 on improvements the operating costs were reduced to $34,450.

The safety work done at the Midvale Steel Company's Philadelphia plant was described by R. F. Gale of that company. This plant has recently made a safety record of 103 days without an off-time accident to an employee. There are about 2,000 men employed in this plant.

This record has been made possible by intensive education and strict discipline in regards to safety. Every man in a crew is held responsible for the safety of his fellow workers. If one gets injured the whole crew is laid off for a period ranging from the remainder of the day to the remainder of the week, from the time the accident occurred, depending on how serious the offense. The interest taken by the plant executives in safety, the educational work done along safety lines and the discipline of the employees for getting injured has made them realize that it pays to work safely.

Steam Produced by Dry Quenching at Flint, Mich.

The Dry Quenching Equipment Corporation, New York, will begin construction, in conjunction with Stevens & Wood, at the Court Street Plant of the Consumers Power Company, Flint, Michigan, of a dry quenching plant to care for approximately 280 tons of coke per day. This installation will provide approximately 280,000 lb. of high-pressure steam per day from heat now wasted through wet quenching. It will also make possible a better grade of domestic coke, reduced maintenance charges and will eliminate cold weather freezing difficulties. Provision is made so that the initial dry quenching installation may be extended to care for 500 tons of coke per day. This is the first dry quenching plant to be installed in Michigan.

Public Utility Earnings Show Increase

Gross earnings of public utility enterprises in February, exclusive of telephone and telegraph companies, as reported to the Department of Commerce by ninety-five companies or systems operating gas, electric light, heat, power, traction and water services and comprising practically all of the important organizations in the United States, were $194,000,000, as compared with $203,000,000 in January, and $187,383,731 in February, 1928.

A.S.T.M. to Prepare Pipe Specifications

In connection with the group committee meeting of the American Society for Testing Materials held in Chicago recently, the Sectional Committee on Standardization of Dimensions and Material of Wrought-Iron and Wrought-Steel Pipe and Tubing formulated a definite program of activities. This program will ultimately result in the preparation of joint A.S.T.M. and A.S.M.E. specifications for all classes of pipe as follows: Lap and butt furnace-welded pipe, seamless pipe, fusion and resistance welded pipe, hammer-welded

pipe, riveted and otherwise fabricated pipe of all types of manufacture.

The American Society for Testing Materials will be officially requested to prepare material specifications for the various types of piping not covered by existing standards. In the joint specifications prepared by the sectional committee, all features of design, dimensions and specification requirements will be correlated into self-contained specifications.

Unveiling of Bronze Tablet by Newcomen Society

At the fourth meeting of the American members, held April 5, 1928, a Committee consisting of Mr. L. F. Loree, Chairman, Dr. Fred R. Low, and Mr. C. E. Davies, Corresponding Secretary for America, was authorized to proceed with suitable markings on the grave of Josiah Hornblower, the man who brought the first steam engine to America and erected it at Belleville, N. J.

The result of the committee's work will be seen on the afternoon of Wednesday, April 24, 1929, when the American members of The Newcomen Society of England will unveil a bronze tablet on the grave of Josiah Hornblower at Belleville, N. J. This tablet will have the following inscription:

JOSIAH HORNBLOWER
PIONEER ENGINEER
DISTINGUISHED CITIZEN
In 1753 he brought from England and erected the first steam "fire" engine in this country.
The Newcomen Society
April 24, 1929

Following the unveiling ceremonies at Belleville the members will return by bus to the Engineers' Club, New York, where the Fifth Annual Dinner and Meeting will be held at 7:00 p.m.

Survey Shows Potential Water Power of Oregon

The recent geological survey of the Department of the Interior gives much information on the natural resources of Oregon with a view to classification as to their highest use or value. The public lands of Oregon are so widely scattered that they are found in practically every section of the State, and information on the resources of the public lands necessarily discloses the value of the adjacent private lands.

Over 1,600 miles of rivers and 50 dam and reservoir sites have been surveyed and shown on published maps, and geologic reports have been made on 48 dam and reservoir sites. Eight manuscript reports on the water-power resources of Oregon have been prepared and opened to public inspection. On the basis of these and other reports, the potential water power of Oregon is estimated at 5,894,000 horsepower for 50 per cent of the time, or about 10 per cent of the total potential power of the United States. In developing most of this power public lands would be affected, and 645,000 acres of it has been classified as valuable for power sites.

Spot * News

SHORTLY BEFORE MIDNIGHT, *March 31, a large rolling-mill engine driving a 19-in. bar mill at the Steubenville, Ohio, plant of the Wheeling Steel Corporation, was wrecked. The cylinder head blew off and injured 15 men, three of them seriously. The plant was badly damaged, and the loss was estimated at $20,000.*

* * *

ANOTHER SHARP DECREASE *in the total production of bituminous coal was reported recently. The estimated tonnage produced during the week ended March 30, according to the National Coal Association's figures was 7,800,000 net tons.*

* * *

CONSTRUCTION *of the Table Rock dam on White River, Mo., has been started by the Empire District Electric Company. It is planned to make this dam one of the largest artificial bodies of water in the United States.*

* * *

THE SHIPPING BOARD *has authorized the sale of the "George E. Weed," a cargo steamer of 8,747 tons, to the Flood Lines, Inc., of San Francisco, with the stipulation that the vessel be converted to Diesel propulsion within a period of eighteen months. The betterments agreed to will involve an outlay of approximately $400,000.*

* * *

THE JAPANESE AMBASSADOR, *Katsuje Debuchi, will be the guest of honor at a dinner to be given by the American Committee of the World Engineering Congress in Washington, April 24. This will be the last formal gathering of the committee prior to sailing for Tokio next fall.*

* * *

AN ORDER *for eleven 400-hp. and two 500-hp. Diesel engines has just been placed with the De La Vergne Machine Company by the Gulf Pipe Line Company for one of its Texas pipe lines.*

* * *

TOCCOA ELECTRIC POWER COMPANY *has engaged Stevens & Wood to complete work on its 20,000-hp. hydro-plant on the Toccoa River near Blue Ridge, Ga. The dam will be 165 ft. high, and the pond will cover about 4,400 acres when filled.*

* * *

A LOSS OF $36.000 *was incurred when fire damaged the power plant of the Kentucky-Tennessee Light & Power Company at Beattyville, Ky.*

* * *

THE LARGEST TRANSFORMER *of the Detroit Edison Company was recently installed in three days. It weighed 118 tons and required a total of 744 man-hours to complete the job.*

Design of Marine Boilers Standardized

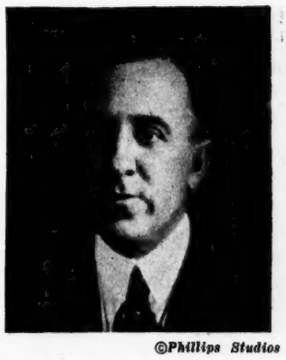
Rules for the design and construction of marine boilers and non-fired pressure vessels were approved at a recent meeting of the executive board of the American Marine Standards Committee. American marine boiler design has heretofore been complicated by regulations requiring different features of construction or thicknesses of metal for any given pressure. A single standard has been embodied in the rules which reflect the committee's opinion as to the best of prevailing marine practice.

The committee also approved a specification for marine boiler steel plates developed in co-operation with the American Society for Testing Materials. Progress is being made on proposed standard specifications for wire rope for marine uses.

Republic Steel Plans to Electrify Mills

The Republic Iron & Steel Company, Youngstown, Ohio, is expected to spend $8,000,000 soon for complete electrification of its big mills, which will be operated by electricity generated by utilizing blast furnace gas. President E. T. McClerry, of Republic, advises that new business is coming to the mills in heavy volume, with a satisfactory outlook for the second quarter.

Men in the News



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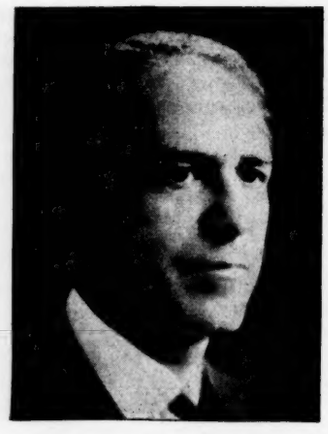
JOSEPH G. WORKER

has been elected vice-president of the Electrical Hoist Manufacturer's Association. He is a director and former president of the Stoker Manufacturer's Association; a director, in charge of sales, of the American Engineering Company; and is affiliated in the capacity of director with the American Fluid Motors Company, of Philadelphia, Affiliated Engineering Companies, Ltd., of Montreal, and Juruick Refrigeration, Inc., of New York City

Col. J. W. Fuller Dies

James W. Fuller, president of the Fuller Company of Catasauqua, Pa., and prominently identified with industrial affairs in Pennsylvania for many years, died on April 4, at St. Luke's Hospital, San Francisco, Calif. He was returning from an extended sojourn in Hawaii when he was stricken with a form of "sleeping sickness" which caused his death.

Colonel Fuller was born April 2, 1873, at Catasauqua, Pa. He was educated at Haverford Preparatory



School, and after completing his course there, went with the McKee Fuller Company where he apprenticed himself to the molders' and machinists' trade. After mastering the details of his vocation, he continued with the corporation, working through the different departments in various capacities, and upon the death of his father he was elected president of the company which was then known as the Fuller-Lehigh Company. He was a pioneer in the pulverized coal field.

On January 4, 1926, the Fuller-Lehigh Company was sold to the Babcock & Wilcox Company, and Colonel Fuller remained with them as chairman of the board until April 1, 1926, when he retired. He then organized the Fuller Company with executive headquarters at Catasauqua for the purpose of handling the Fuller-Kinyon system for materials other than pulverized fuel which part of the business was not included in the sale to the Babcock & Wilcox Company. Until his death he was president of the Fuller Company and also president of the Allentown Portland Cement Company.

Colonel Fuller was a member of the American Society of Mechanical Engineers, the Engineers Club of New York, and many social and country clubs in Pennsylvania and New York. His recreations were outdoor sports and he was a keen enthusiast and lover of horses with which he won many prizes at various exhibits.

He served on the military staff of Governor John K. Tenor, where he received the rank of Colonel.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May 2, 3, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Big Wind Inn, Lake of Bays, Ontario, Can., June 27-29. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

Northwest Electric Light and Power Association. 22nd Annual Convention, June 26-29, 1929, at Seattle, Wash. Registration and information: J. J. Hayes, Westinghouse Electric & Manufacturing Company, Seattle, Wash.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

CHARLES E. CARPENTER, for many years president and general manager of E. F. Houghton & Company, of Philadelphia, manufacturers of oils and leathers for industrial purposes, died in Miami Beach, April 7, of heart disease. He was in his 67th year. In addition to an active industrial career, Mr. Carpenter was prominent in the political and social life of Philadelphia.

Large Hydro Project for Tennessee River

A certificate of convenience and necessity from the Tennessee railroad and public utilities commission for the development of a hydro-electric plant almost equal to that of Muscle Shoals, was sought recently by Robert H. McNeill, of Washington, D. C., who asks that such certificate be issued on the Aurora, Ky., dam site on the Tennessee River.

While the outline of the project submitted with the application calls for an initial development of 240,000 hp. and an initial expenditure of $32,800,000, it is proposed ultimately to develop 528,000 hp. at an approximate cost of $43,000,000.

In size the project compares favorably with the 665,000 hp. which will be the ultimate energy to be developed at Muscle Shoals.

Foreign Engineers to Be Entertained

Arrangements for the reception of 100 of Europe's most distinguished engineers and scientists, who will arrive here during the summer en route to the World Engineering Congress at Tokio, have been placed in charge of Roy V. Wright, president of the United Engineering Societies, as Chairman of the New York Reception Committee according to a recent announcement from Maurice Holland, Executive Secretary of the American Committee of the Congress, of which Dr. Elmer A. Sperry is Chairman. Mr. Wright will be aided by a committee of New York Engineers.

It is expected that the foreign engineers will arrive in separate delegations of approximately forty each from Great Britain and Germany, and the rest from Sweden, Denmark, France and Italy, probably during August and September. Each of these countries has indicated that its foremost engineers will be included in its delegation. Mr. Wright's committee will plan inspection trips for the foreign delegations, and arrange for their entertainment and transportation while here.

Chief Engineer of Federal Power Commission Ordered to West Point

After having served for five years with the Federal Power Commission. Major Glen E. Edgerton has been ordered to the U. S. Military Academy to serve as an instructor of civil and military engineering.

Before becoming chief engineer of the commission Major Edgerton occupied the office of assistant chief. In that period he supervised the engineering and economic work during more than half the life of the commission since its organization in 1920. Before the end of his term of service he will have passed on nearly 300 licenses representing more than four million horsepower.

PERSONALS

DR. ELMER AMBROSE SPERRY, president of the American Society of Mechanical Engineers, has been elected a "Member with Distinction in Tau Beta Pi." This honor has been conferred only once before. Doctor Sperry's initiation will take place on April 18, at the Hotel Astor, New York City.

DANIEL W. SNYDER, JR., for the last five years chief operating executive of the electrified lines of the Illinois Terminal Railroad System, has been elected president of the Missouri Power and Light Company, Kansas City, Mo., a subsidiary of the North American Light and Power Company. He will have charge of utilities service in 150 Missouri communities.

R. Z. ZIMMERMAN has been elected vice president of the United Gas Improvement Company, Philadelphia, Pa., in charge of purchasing. He suceeds J. A. Pearson, who resigned after 40 years of service.

W. R. PUTNAM, vice president and general manager, Idaho Power Company, Boise, has resigned to take up new duties with the Electric Bond & Share Company in New York. He will be succeeded by M. L. Hibbard, assistant general manager of the Idaho company and former chief operating engineer for the Northern States Power Company at Minneapolis.

L. E. MORSE has been appointed secretary-treasurer of the Washington Water Power Company, Spokane, to suceed V. G. Shinkle, who resigned last December.

BUSINESS NOTES

THE BAILEY METER COMPANY announces the formation of a subsidiary company, Bailey Meters (Aust.) Limited, with headquarters at Kembla Buildings, Margaret Street, Sydney, N. S. W., Australia. C. W. Payn will act as managing director of the new company.

ERIE CITY IRON WORKS, Erie, Pa., reports the appointment of the Schley-Nash Company, Columbia Bank Building, Pittsburgh, Pa., as sales representatives for their Pittsburgh territory.

THE ROLLER-SMITH COMPANY has made two additions to its sales organization; J. C. McDougall, Alaska Building, Seattle, Wash., and Carl P. Lohr, 401 National Bank of Commerce Building, St. Louis, Mo.

THE W. C. WEST COMPANY has made the Rooney-Krafft Company, located in the Atco Building, Tulsa, Okla., its representative in the Oklahoma and Arkansas territories.

With the Society Sections

A. S. M. E., Metropolitan Section. Meeting April 19, Division of Applied Mechanics, Subject: "Crankless Reciprocating Engines and Pumps," by A. G. M. Michell, Michell-Crankless Engine Corp. Meeting April 24, Oil and Gas Power Division, Subject: "Diesel Power Plants for Large Buildings," by Edgar J. Kates, Consulting Engineer. Meeting April 29, Power Division, Subject: "The Modern Marine Power Plant," by W. Flanders and P. Lamb.

A. S. M. E., Detroit Section. Meeting April 19, at Ann Arbor, Mich. Presentation of Life Membership to Dean M. E. Cooley by Alex Dow, President, Detroit Edison Company, Detroit, Mich.

A. S. M. E., Philadelphia Section. Meeting, April 23. Subjects: "Petroleum and Oil—The use of centrifugal pumps for hot and cold oil and other liquids at various pressure up to 1,400 lb. per sq.in.," by W. R. Layne, Chief Engineer, Byron-Jackson Pump Manufacturing Company, Dallas, Texas; "Diesel Engine," by Julius Kuttner, Editor, Oil Engine Power, New York, N. Y.

Plant Engineers' Club of Boston. Meeting, April 17, at South Walpole, Mass. Subject: "The Use of High Boiler Pressure in an Industrial Plant," by Mr. Conrad, Plant Engineer, Bird & Sons, Inc., South Walpole, Mass.

The Newcomen Society. Fifth American meeting, April 24. Unveiling of tablet on grave of Josiah Hornblower, Belleville, N. J., at 4:30 p.m. Dinner and meeting, Engineers' Club, at 7:00 p.m. Subjects: "First Steam Engine in America," by L. F. Loree; "Evolution of the Typewriter," by John H. Barr.

TRADE CATALOGS

CO_2 AND DRAFT RECORDERS — The Hays Corporation, Michigan City, Ind., in a new catalog, RA29, describes the simplified and improved Hays CO_2 recorder, which may be water operated or motor driven. Combination instruments are available to record draft or draft and flue gas temperatures in addition to the CO_2 reading. An analysis of a CO_2 and draft recorder chart and installation instructions are of value. Other Hays instruments given space are the gas analyzer, portable test sets and draft gages.

CONTROL VALVES—Catalog No. 2000, put out by the Bristol Company, of Waterbury, Conn., contains information on automatic control valves of motor and magnet types. The 20 pages contain many illustrations, two interesting records of temperature control as accomplished manually and automatically, a loose-leaf control data sheet, and complete price list.

INSTRUMENT DATA BOOK — The Brown Instrument Company, Philadelphia, Pa. has published a 48-page book providing data from which a suitable plan of instrument equipment covering temperatures, pressure flows, liquid levels, per cent of CO_2 and speeds can be compiled. It is illustrated throughout and contains a large diagrammatic drawing of a typical steam power plant, indicating places in which instruments could be profitably used.

STEAM TURBINES — Type *S* Multi-Stage Steam Turbines, Form 1921-B is the designation and subject of a recent leaflet put out by the Moore Steam Turbine Corporation, Wellsville, N. Y. It contains a line drawing of a cross-section of one of the turbines.

SPEED REDUCERS—A 24-page booklet on speed reducing transmissions, giving illustrations, tables of horsepower ratings and line drawings, is issued by the Morrison Machine Company, 204 Van Houten St., Paterson, N. J.

TRANSFORMERS—The Wagner Electric Corporation of St. Louis, Missouri, has put out a bulletin, No. 161, containing detailed instructions for the installations and operation of transformers.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	1.25@1.06
Smokeless	Cincinnati	2.15@ 2.25
Smokeless	Chicago	1.75@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.55@ 1.65
Gas Slack	Pittsburgh	1.10@ 1.25
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75
Barley	New York	1.50

FUEL OIL

New York—Apr. 11, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 6.25c. per gal.

St. Louis—Apr. 3, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.40 per bbl. or 42 gal.; 26@28 deg., $1.45 per bbl.; 28@30 deg., $1.50 per bbl.; 30@32 deg., $1.55 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., distillate. 5.75c.

Pittsburgh—Apr. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—Apr. 4, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 23@27 deg., $2.10@$2.16 per bbl.

Cincinnati—Apr. 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Apr. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Apr. 8, tank-car lots, f.o.b. 12@14 deg Baumé, 4.54c. per gal.; 28@32 deg., 5.62c. per gal.

Dallas—Apr. 1, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., El Centro—Imperial Irrigation Dist., plans to vote $2,100,000 bonds for the construction of a hydro-electric power plant.

Calif., Los Angeles—Adohr Creamery Co., 101 La Cienega Blvd., awarded contract for the construction of a power house to H. A. Nichols, 90 Slauson Ave. Estimated cost $3,950.

Colo., Model — Colorado Interstate Gas Co., Denver. Will build a gas booster station on Amarillo-Texas-Denver natural gas line here. Estimated cost $500,000. Work will be done under the supervision of Ford, Bacon & Davis, 39 Broadway, New York, N. Y., Engrs.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded masonry contract for a 40 x 67 ft. sub-station at 10-12 Lake St. E. Estimated cost $115,000.

Ill., Chicago—Syndicate, c/o Jacobs, Karlin & Smith, 228 North La Salle St., Archts., is having plans prepared for the construction of an apartment building including central refrigeration plant at Calumet Ave. and 68th St. Estimated cost $1,000,000.

Kan., Newton—City will soon award contract for the construction of a sewage disposal plant including pumping station, three 450 g.p.m. vertical centrifugal sewage pumps, one horizontal centrifugal sludge pump, etc. Black & Veatch, Mutual Bldg., Kansas City, are engineers.

Minn., Wayzata—City, G. L. Mullens, will receive bids until Apr. 24, for the construction of a waterworks system including pumping plant, mains, etc. Estimated cost $55,000. Rose & Harris, 412 Oak Grove St., Minneapolis, are engineers.

Neb., Edison — City defeated bond election Apr. 2, for $18,000 bonds for waterworks improvements to include pump house, pumps, tank on tower, etc. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, Engr.

Neb., Omaha—Jerpe Cold Storage Co., 12th and Douglas Sts., awarded contract for the construction of a cold storage plant to V. R. Gould Co., 1221 City National Bldg. Estimated cost $50,000.

N. J., Holland — Associated Gas & Electric Co., 61 Broadway, New York, N. Y., awarded contract for the design and construction of a steam power plant here, to W. S. Barstow Engineering Co., 50 Pine St., New York, N. Y. Engrs. and Contrs. Estimated cost $2,000,000. Engineers taking bids on equipment, etc. Work by day labor.

N. C., Lumberton—City plans an election to vote $65,000 bonds for extensions and improvement to waterworks system, also improvements to power plant.

O., Cincinnati — Hamilton County, will soon award contract for the construction of sewage treatment plant including pumping station and equipment. Estimated cost $92,999.

Ore., Eugene—City plans an election about June 1 to vote $1,250,000 bonds for the construction of Leaburg hydro-electric plant. W. C. Clubb, is city engineer.

Pa., Philadelphia — Pennsylvania R.R., Broad St. Station, awarded contract for the construction of a 21 story office building at 16-17 Pennsylvania Blvd. to James T. Stewart Co., 17 East 42nd St., New York, also a 100 x 118 ft. power house at 33rd and Market Sts. to United Engineers & Construction Co., 112 North Broad St. Estimated cost $2,000,000 and $700,000 respectively.

R. I., Newport—Owner, c/o Howe & Church, Turks Head Bldg., Providence, is receiving bids for the construction of a power house here.

S. D., Sioux Falls—Bd. of Control, Pierre, will soon receive bids for the construction of a power house, etc. at State School for Deaf here. Estimated cost $76,750. Hugill & Blatherwick, 367 Boyce-Greeley Bldg., Sioux Falls, are architects.

Tex., Carrizzo Springs—Central Power & Light Co., Frost Bldg., San Antonio, plans the construction of a 35 ton raw water ice plant here. Estimated cost $50,000 Work will probably be done by day labor.

Tex., El Paso—El Paso Electric Co., plans the construction of a power plant.

Tex., Odessa—Texas Electric Service Co., Odessa, or Southwestern Power & Light Co., 71 Broadway, New York, subsidiary of Electric Bond & Share Co., New York, N. Y., plans to rebuild portion of electric power plant including equipment destroyed by fire. Private plans.

Tex., Dallas—City received lowest bids for the construction of a pumping station in connection with waterworks from T. F. Larkin Co,. also steam plant and equipment from Westinghouse Electric & Mfg. Co., 121 East Baltimore St., Baltimore, Md. Total estimated cost $470,000 to $950,000.

Wash., Renton—Puget Sound Power & Light Co., A. W. Leonard, Pres., Stuart Bldg., Seattle, plans the construction of second unit of Shuffleton steam power plant on Lake Washington near here, to increase the capacity from 50,000 to 100,000 hp. Estimated cost $2,500,000. Structure will house three boilers and three turbines of 50,000 hp. Work will be done under the supervision of W. D. Shannon, Chief Engineer. Contract awarded for oil circuit breakers.

Man., Fort Osborne — Dept. of Public Works, Parliament Bldg., Ottawa, Ont., plans the construction of a power plant at Barracks here.

Equipment Wanted

Condenser Set—Bd. of Water Commissioners, Dunkirk, N. Y., will receive bids until Apr. 30, for furnishing and installing of a new frequency condenser set in electric light plant.

Engine and Generator — City of Logan, Utah, H. C. Maughan, Supt., will receive bids until Apr. 23, for the installation of a 1,000 to 1,200 hp. engine and electric generator for electric light plant. Estimated cost $60,000.

Power Plant Equipment—Indiana Blind School, 40 East North Rd., Indianapolis, Ind., is in the market for power plant equipment including boilers, deep well pumps, stokers, etc. for dormitory buildings at 75th and College Sts. Estimated cost $425,000.

Pump—City of Lacon, Ill., plans the installation of a pump in waterworks system.

Pumping Equipment—City of Nixon, Tex., plans to purchase pumping equipment, etc. for proposed waterworks improvements.

Pumping Unit, Etc.—City of Center, Tex., pumping unit, etc., for proposed waterworks improvements. Estimated cost $25,000.

Pumps, etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until May 8, for motor driven centrifugal fire pumps, portable gasoline-engine driven pumping unit, etc. at Naval Radio Station, Jupiter, Fla.

Pumps, etc.—City of Elgin, Ill., plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $46,000.

Pumps, etc. — City of Mondamin, Ia., plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $18,000.

Pumps, etc.—City of Lafayette, La., will receive bids until Apr. 30, for three sewage pumps, etc. for proposed sewage treatment work.

Pumps, Etc.—Haskell Institute, C. M. Blair, Lawrence, Kan., will receive bids until Apr. 29 for pumps, etc. for proposed sewage treatment plant.

Turbines, Generators, Switchboard, etc.—J. F. Donovan, City Mgr., Auburn, N. Y., will receive bids until Apr. 30, for 180 hp. vertical shaft hydraulic turbine connected to generator; 156 kva. electric generator mounting on vertical shaft hydraulic turbine; switchboard and electric controlling apparatus.

Industrial Projects

Conn., Bridgeport—BRASS FOUNDRY—Bridgeport Brass Co., R. Day, Gen. Mgr., awarded contract for a 1 story, 75 x 200 ft. foundry on Housatonic Ave. to Hewlett Co., 886 Main St. Estimated cost $100,000.

Ind. Jasper—CHAIR FACTORY and HEATING PLANT—Jasper Chair Co., awarded contract for the construction of a factory including heating plant to C. Kanzler, 500 Furniture Bldg., Evansville. Estimated cost $150,000.

Md., Baltimore—AIRPLANE FACTORY G. L. Martin Co., 16800 Clair St., Cleveland, awarded contract for a 1 story, 302 x 903 ft. factory here, to Hughes-Foulkrod Co., Schaff Bldg., Philadelphia, Pa. Estimated cost $1,250,000.

Md., Baltimore — SOAP FACTORY — Procter & Gamble Co., Gwynne Bldg., Cincinnati, O., will receive bids after Apr. 20, for the construction of a soap factory here. Estimated cost $4,000,000. H. Manley, 5 East 53rd St., New York, is architect.

Mass., Attleboro — PRESSED STEEL PLANT — Mossberg Pressed Steel Co., F. Mossberg, 81 West St., plans a 1 story, 100 x 300 ft. plant. Estimated cost $200,000. Architect not selected.

Mich., Jackson — RADIO FACTORY — Sparks-Withington Co., North Main St., awarded contract for a 3 story, 60 x 250 ft. radio factory, to Boldt Construction Co., 1969 East 70th St., Cleveland, O. Estimated cost $150,000.

Mich., Pontiac — IRON WORKS — Hancock Iron Works, 52 West Pike St., is having plans prepared for a 1 story, 150 x 500 ft. structural shop and iron works on Paddock St. Private plans.

Mich., River Rouge—PAPER FACTORY —Detroit Wax Paper Co., 547 Harper Ave., Detroit, is having plans prepared for a 1 story, 210 x 600 ft. paper factory on Pleasant Ave. Estimated cost $600,000. Private plans. Electric motors, etc. will be required.

N. Y., New York — FACTORY and BOILER ROOM — Evmol Realty Corp., R. E. King, Pres., 27 Cedar St., plans altering 3 story, 68 x 121 ft. factory including boiler room, etc. at 221 East 129th St. Estimated cost $40,000. F. S. Parker, 19 West 57th St., is architect.

Okla., Henryetta—GLASS FACTORY—Pittsburg Plate Glass Co., Frick Bldg., Pittsburgh, Pa., plans the construction of a glass factory here. Estimated cost $1,000,000. Private plans.

Pa., East Pittsburgh—TEST BUILDING —Westinghouse Electric & Mfg. Co., will soon award contract for a 1 story, 60 x 180 ft. test building. Estimated cost $100,000. B. H. Prack, Martin Bldg., Pittsburgh, is architect.

Ont., Copper Cliff—COPPER REFINERY —International Nickel Co., 67 Wall St., New York, N. Y. and Consolidated Mining & Smelting Co., Canadian Pacific Bldg., Toronto, will build a copper refinery, 120,000 ton annual capacity here. Estimated cost $4,000,000. Work will be done by day labor.

Ont., Harrow — CANNING PLANT and BOILER HOUSE — W. Clark, Ltd., is having plans prepared for a 3 story, 50 x 100 ft. canning plant including boiler house, and installation of a 600 hp. boiler, etc. Estimated cost $100,000. Equipment will be required.

Ont., Mount Dennis — FACTORY — Ferrante Electric Ltd., 26 Noble St., Toronto, is having plans prepared for the construction of a factory here. Estimated cost $100,000. Ewart, Armer & Byam Ltd., 36 Toronto St., Toronto, are engineers.

Japan, Tokyo—FACTORY ADDITION—Nippon Electric Co. awarded contract for addition to factory to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $250,000.